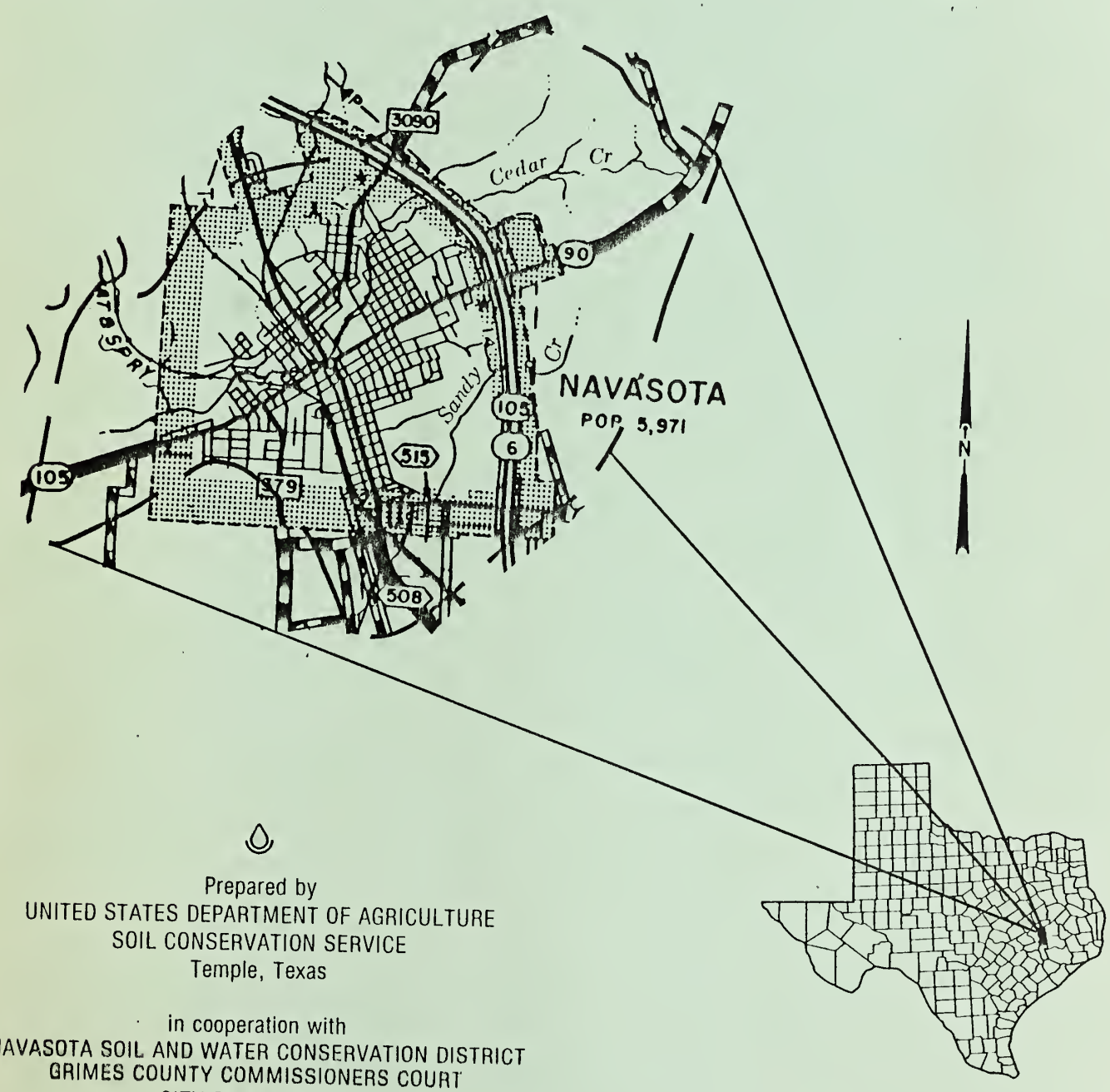
CEDAR CREEK
&
WEST TRIBUTARY OF SANDY CREEK

FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS



Prepared by
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Temple, Texas

in cooperation with
NAVASOTA SOIL AND WATER CONSERVATION DISTRICT
GRIMES COUNTY COMMISSIONERS COURT
CITY OF NAVASOTA
and the
TEXAS WATER COMMISSION

OCTOBER 1985

FLOOD PLAIN MANAGEMENT STUDY

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W. R. Poage Federal Building

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FLOOD PLAIN MANAGEMENT STUDY
CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK
GRIMES COUNTY, TEXAS

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INTRODUCTION

This flood plain management study report identifies areas of flood plain subject to flooding by Cedar Creek and West Tributary of Sandy Creek within the City of Navasota and vicinity, Grimes County, Texas.

The assistance and cooperation given by the agencies, organizations and individuals during the Cedar Creek and West Tributary of Sandy Creek Flood Plain Management Study is greatly appreciated. These include:

-- Navasota Soil and Water Conservation District

-- City of Navasota

-- Grimes County Commissioners Court

Special appreciation is extended to the individuals who contributed information for the study. Appreciation is also extended to the landowners who permitted access to their property for surveys, photographs, and reconnaissance.

In 1976 the Soil Conservation Service (SCS) made a preliminary investigation of the urban flood problem in the City of Navasota. The 1976 investigation addressed the flood problems along the West Tributary of Sandy Creek. SCS found during this investigation that frequent flooding of urban and industrial properties within and adjacent to the City of Navasota is a major problem. SCS found that "under the present level of development, about 80 residential units, 2 retail business properties, a 4-building school complex and 2 large manufacturing plants are subject to

moderate to severe floodwater damage from a 100-year flood event. In addition, about 80 acres of industrial land has a flood hazard that is a deterrent to development."

The 1976 investigation states "flooding that causes moderate damage to residential, retail business, and public properties, and severe damage to industrial properties has been frequent during recent years. Damaging floods of similar magnitude occurred in 1971, 1973, and 1974."

The 1976 investigation estimated a favorable benefit-cost ratio could be obtained with structural measures designed to reduce flood damages and recommended that project-type planning be initiated.

In 1982, the SCS made a followup study of the problem and estimated about 100-120 residences, businesses and public buildings would flood from a 100-year flood event and that a favorable benefit-cost ratio could be obtained with project-type action.

Cedar Creek also causes flooding problems within the City of Navasota. It is estimated 70 residences and 15-20 business properties would sustain major flood damages from the 100-year flood event. The upper reaches of the Cedar Creek flood plain is a rapidly developing residential area. Also, recent construction of the State Highway 6 Loop has attracted new business and industrial development in the upper reaches of the Cedar Creek flood plain.

Future development is expected to occur within the flood plains of both Cedar Creek and the West Tributary of Sandy Creek.

The City of Navasota is presently in the emergency flood insurance program; However, no detailed flood insurance study has been made.

This cooperative study was requested by the City of Navasota, the Navasota Soil and Water Conservation District, the Grimes County Commissioners Court, and the Texas Water Commission order to obtain a factual basis for reducing future flood damages and flood hazards through carefully considered and well planned local regulations and use of the flood plain.

The study was conducted according to the April 1983 Plan of Work developed and endorsed by the above named requesting entities and the Soil Conservation Service.

The SCS conducts cooperative flood plain management studies in Texas through the November 1973 Joint Coordination Agreement (Revised 10/30/78) between the SCS and the Texas Department of Water Resources 1/. SCS assists state agencies and communities in the development, revision, and implementation of their flood plain management programs by carrying out cooperative flood plain management studies (FPMS's) in accordance with Federal Level Recommendation 3 of "A Unified National Program for Flood Plain Management," and Section 6 of Public Law 83-566. The principles contained in Executive Order 11988, Flood Plain Management, are addressed in this part.

1/ Changed to Texas Water Commission in 1985 by the 69th Texas Legislature.

Topographic data for this study were obtained from field surveys and Geological Survey topographic maps. Rainfall frequency data were obtained from Weather Bureau Technical Paper No. 40, Rainfall Frequency Atlas of the United States. Peak discharge values were determined by flood routing various storm frequencies with a 24-hour rainfall duration using SCS Technical Release No. 20, A Computer Program for Project Formulation, Hydrology. Water surface profiles were developed by the Modified Slope Area Method using SCS Technical Release No. 61, WSP2, A Computer Program for Determining Flood Elevations and Flood Areas for Certain Flow Rates.

Peak discharges developed using Geological Survey Water Resources Investigations 77-110 Open File Report, "Technique or Estimating the Magnitude and Frequency of Floods in Texas" were used for comparison purposes only since this method has no procedure for evaluating the effects of watershed structural improvements.

DESCRIPTION OF STUDY AREA

The study area includes Cedar Creek and an unnamed tributary of Sandy Creek. This unnamed creek is designated West Tributary of Sandy Creek in this study. The study area is in Geological Survey Hydrologic Unit Number 12070103. The Cedar Creek and West Tributary of Sandy Creek watershed is in the Water Resources Council Texas-Gulf Region, Subregion 07, and Brazos River Basin.

Cedar Creek heads approximately 1.5 miles northeast of the Navasota city limits and flows in a southerly direction through the City of Navasota to

the central business district. It exits from the central business district in a southwesterly direction and outlets into the Navasota River approximately 1.5 miles northwest of the Navasota central business district.

The West Tributary of Sandy Creek heads approximately 0.6 mile east of the Navasota city limits and flows in a southwesterly direction into the east part of the City of Navasota, then continues through the east part of the city in a southerly direction to its confluence with Sandy Creek approximately 0.9 mile south of the Navasota city limits. The Cedar Creek watershed has a drainage area of 6.2 square miles or 3,960 acres. The West Tributary of Sandy Creek has a drainage area of 2.1 square miles or 1,334 acres. The total drainage area of the study area is 8.3 square miles or 5,294 acres.

The City of Navasota is the only community center in the study area. The 1980 census gives the population of Navasota as 5,971.

The Index and Study Area Map, Appendix, page 9, shows the streams and areas that were studied. The total channel length of stream reaches that were studied in detail is 7.6 miles. This includes 4.6 miles on the flood plain of Cedar Creek, 0.6 miles on Cedar Creek Tributary 1, and 2.4 miles on the West Tributary of Sandy Creek.

The Cedar Creek and West Tributary of Sandy Creek watershed has a moist subhumid climate with moderate temperatures. The winters are mild with a

January average minimum temperature of 40 degrees Fahrenheit. The July average maximum temperature is 96 degrees Fahrenheit. The mean annual rainfall is 40.5 inches with an irregular seasonal distribution. The average growing season is 278 days.

The soils are of the Texas Blackland Prairie Land Resource Area. They have loamy surface layers over clayey subsoils.

NATURAL VALUES

The major portion of the Cedar Creek and West Tributary of Sandy Creek watershed is located in the Blackland Prairie Vegetational Area with a small area in the upper part of the watershed in the Post Oak Savannah Vegetational Area, as described by F.W. Gould in Texas Plants -- A Checklist and Ecological Summary.

Historically, the Blackland Prairie was covered with mid and tall grasses with some woody vegetation along the major drainageways. The Post Oak Savannah Vegetational Area contained areas of post oak and blackjack oak trees, and open areas of grasses. The major climax grasses in these vegetational areas are little bluestem, big bluestem, Indiangrass, switchgrass and sideoats grama.

The present land uses in the watershed are shown in the following table.

Table 1
Land Use

Land Use	Acres	Percent of Watershed
Cropland	297	6
Pastureland	1898	36
Native grassland	595	11
Woods	340	6
Water	20	1
Urban	2144	40
Total	5294	100

Urban areas, including the City of Navasota, highways and other residences comprise 41 percent of the watershed.

Pastureland makes up 36 percent of the watershed. The primary pasture grass is coastal bermuda. Other plant species such as broomweed, silver bluestem, various species of dropseeds, panicums, annual grasses and forbs are present on some of the pastureland.

Open rangeland, normally located on the steeper slopes, comprises 11 percent of the watershed. Major grass species found on the rangeland areas include little bluestem, sideoats grama, silver bluestem, KR bluestem, threeawn, bermudagrass, Texas wintergrass, various species of panicums and dropseeds. Woody species such as mesquite, cedar, huisache and McCartney rose are found on some of the rangeland.

The pastureland and rangeland are used primarily for beef cattle production.

Woody vegetation occurs mainly along the watercourses and in small blocks. Principal woody species include pecan, cedar, elm, hackberry, black willow, ash, cottonwood and various species of oak. Other species are hawthorns, greenbriar, yaupon, mesquite, and huisache.

Six percent of the watershed remains in cropland. The major crop being grown is small grain.

The areas of water in the watershed consist of small reservoirs and farm ponds.

The major and most important natural value of the Cedar Creek and West Tributary of Sandy Creek flood plain is its ability to transport floodwater.

PRIME FARMLAND SOILS

Small areas of prime farmland soils occur in the watershed. According to the general soil survey map, the watershed is comprised of two soil associations: Latium-Frelsburg and Burleson-Mabank-Wilson. One soil type in each association is considered prime when the slopes are less than five percent. These are Frelsburg and Burleson.

FISH AND WILDLIFE HABITAT

The streamcourses in the watershed have ephemeral flow. The fishery resource is limited to farm ponds and two small reservoirs. The principal species of fish in these impoundments are largemouth bass, channel catfish, bullhead catfish, and various species of sunfish.

Although the watershed is comprised mainly of urban areas and pastureland, narrow belts of woody vegetation occur along many of the drainageways. These riparian woodlands provide travelways, "edge habitat", and a diversity of wildlife habitat.

The principal game species occurring in the watershed are mourning dove and bobwhite quail.

Other wildlife species found mainly along the wooded streamcourses in the watershed include fox squirrel, raccoon, opossum, skunk, fox and coyote. Cottontails, jackrabbits and a variety of rodents and songbirds are found throughout the watershed.

WETLANDS

Type 5 wetland (Inland open freshwater), as defined by U.S. Fish and Wildlife Service Circular 39, is the only wetland in the watershed.
This wetland type occurs in water areas having ten feet or less depth and is bordered by emergent aquatic vegetation.

THREATENED AND ENDANGERED SPECIES

This watershed is in the range of occurrence of one species which has been designated by the U.S. Fish and Wildlife Service as being endangered. The Artic peregrine falcon (Falco peregrinus tundrus) is migatory and may migrate through the watershed.

FLOOD PROBLEMS

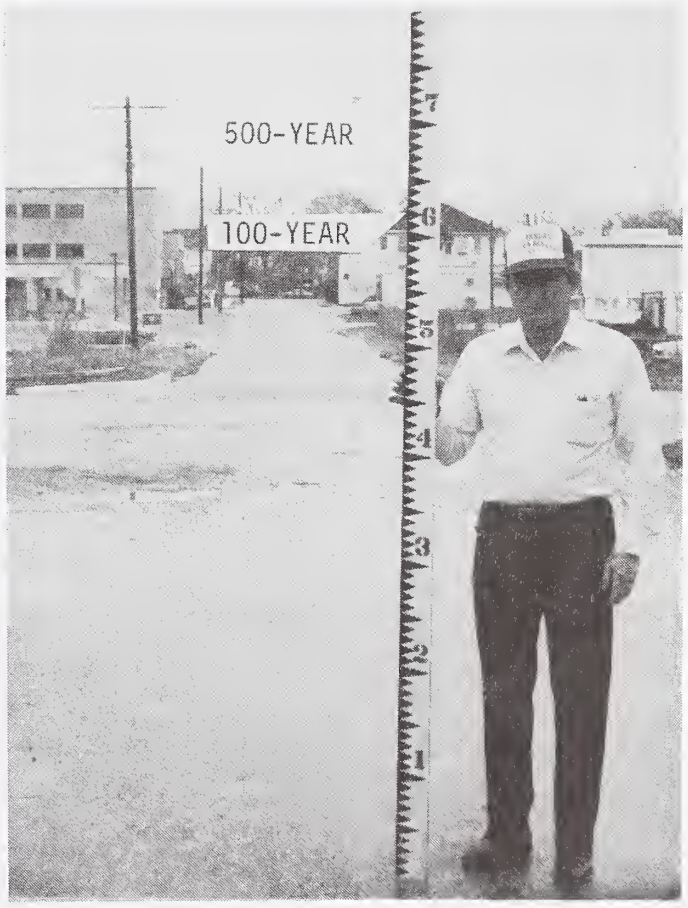
Floods from Cedar Creek damage residences, businesses, other buildings, streets and highways in the City of Navasota. Approximately 95 buildings would be affected by the 500-year frequency flood. These 95 buildings with contents have an estimated value of $8,257,500. Approximately 88 buildings would be affected by the 100-year flood. These 88 buildings with contents have an estimated value of $6,552,500.

Floods from the West Tributary of Sandy Creek also damage residences, businesses, other buildings, streets and highways in the City of Navasota. Detailed field surveys were made to obtain first floor elevations of buildings in the flood plain. The detailed surveys show 87 buildings would be affected by the 500-year frequency flood. These 87 buildings with contents have an estimated value of $609,000. Also, 73 buildings would be affected by the 100-year flood. These 73 buildings with contents have an estimated value of $461,000.

Potential flood heights for 100-year and 500-year floods photographed at various locations to illustrate the flood problems are shown on pages 11 and 12 (Figures 1 through 4).

FIGURE 1 -- Potential flood heights at Cross Section 19, Station 14255, at the Duke Street bridge on Cedar Creek.

FIGURE 2 -- Potential flood heights at Cross Section 25, Station 15145, at the Old Millican Road bridge on Cedar Creek.



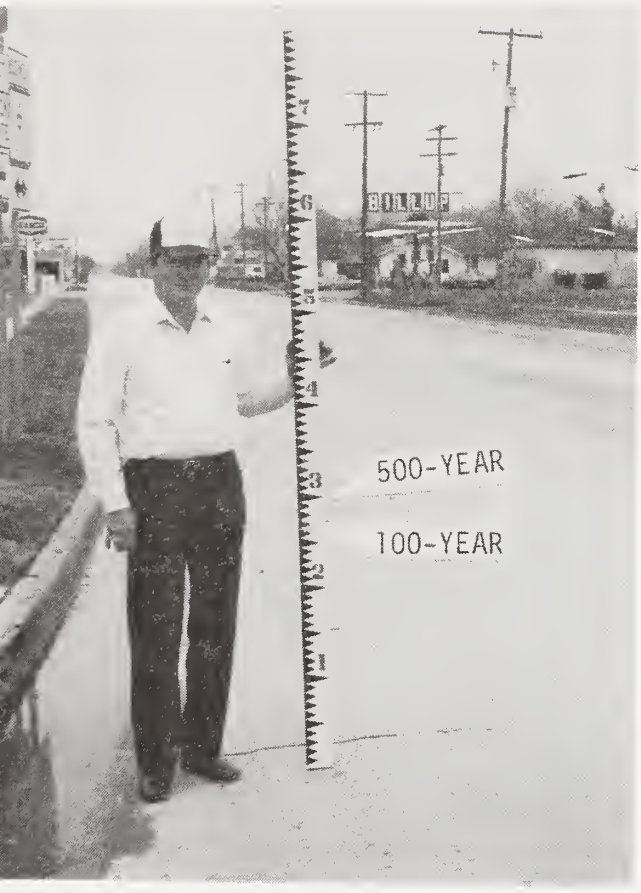


FIGURE 3 -- Potential flood heights at Cross Section 56, Station 5870, at the intersection of State Highway 508 and 105, on the West Tributary of Sandy Creek.

FIGURE 4 -- Potential flood heights at Cross Section 59, Station 6315, approximately 1050 feet northwest of the Old Houston Road bridge on the West Tributary of Sandy Creek.

Tabulated below are the acreages of rural and urban areas subject to inundation by the 100-year and 500-year floods.

CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK
FLOODED AREAS

	Rural (Acres)	Urban (Acres)	Total (Acres)
Within the 100-year Frequency flood plain	427	272	699
Within the 500-year frequency flood plain	490	328	818

Upstream flood plain and watershed land use changes anticipated by local officials within the next 10 to 15 years are not expected to significantly affect future flood elevations on the flood plains of the Cedar Creek and West Tributary of Sandy Creek study area.

EXISTING FLOOD PLAIN MANAGEMENT

The 61st Texas Legislature in 1969 enacted the Texas Flood Control and Insurance Act, Article 8280-13 VACS, and Article 1581e-1 VACS. Article 8280-13 named the Texas Water Development Board and the State Board of

Insurance as the responsible state-level agencies in respect to the National Flood Insurance Program. In 1985, the 69th Texas Legislature created the Texas Water Development Board and the Texas Water Commission from the Texas Department of Water Resources. Article 8280-13 was codified in Texas Water Code (Subchapter I, Section 16.311), and responsibility for the flood insurance program in Texas was assigned to the Texas Water Commission and the State Board of Insurance. Subchapter I, Section 16.315 of the Code authorizes all political subdivisions, including cities, counties, and many types of special purpose districts and authorities, to take all necessary and reasonable actions to comply with the requirements and criteria of the National Flood Insurance Program.

At the present time, state-level statutory controls on use and management of flood hazard areas are fairly limited. Subchapter G, Section 16.236 of the Texas Water Code requires the Texas Water Commission or the local political entity to approve plans for any levee or other such improvement which may change floodflows of any stream in Texas that is subject to floods. Also, in December 1977, Governor Briscoe issued Executive Order No. 34-A calling for state agencies to implement a flood plain management program for state-owned property and facilities. This state program will utilize state agency rules and regulations calling for evaluation of flood hazards and will conform to the minimum flood plain management criteria established by the U.S. Department of Housing and Urban Development for the National Flood Insurance Program.

The City of Navasota is presently in the emergency flood insurance program.

ALTERNATIVES FOR FLOOD PLAIN MANAGEMENT

PRESENT CONDITIONS

Residences, businesses and public buildings are presently located within the study area flood plain and additional development is underway.

The area adjoining the newly constructed portion of State Highway 6 which crosses the upper reaches of Cedar Creek, Cedar Creek Tributary 1 and the West Tributary of Sandy Creek is developing rapidly. Development of the area between State Highway 6 and the existing construction within the City of Navasota is expected to accelerate during the next few years. The Federal Insurance Administration published a Flood Hazard Boundary Map, effective October 8, 1976. This map was developed using approximate methods and does not show flood elevations. Flood elevations are necessary in order to set first floor elevations for new construction high enough to reduce damage from potential floods.

LAND TREATMENT

Effective conservation land treatment is presently being carried out by landowners and operators in the watershed. Excess runoff or erosion and sedimentation due to lack of conservation land treatment is not a major cause of Cedar Creek and West Tributary of Sandy Creek flooding.

PRESERVATION AND RESTORATION OF NATURAL VALUES

Since the primary natural value of the Cedar Creek and West Tributary of Sandy Creek flood plain is its ability to transport floodwaters, encroachment onto the flood hazard areas of the flood plain with obstacles which interfere with the movement of floodwater should be avoided to preserve its present flowage capacity.

The woody areas along the streambanks in the Cedar Creek and West Tributary of Sandy Creek flood plain are considered important environmental corridors and wildlife habitat. Provisions should be made to protect these woody areas in the planning and development of new urban areas.

There is an excellent opportunity to use nonprime farmland soils for construction sites and other non-farm uses in order to preserve prime farmland since ample nonprime farmland soils are available in the watershed. Information on prime farmland soils in the study area may be obtained from the Soil Conservation Service office at Navasota, Texas.

NONSTRUCTURAL MEASURES

Nonstructural measures which will help reduce or minimize flood losses include flood proofing, flood warning systems, relocation, zoning regulations, participation in the national flood insurance program, emergency preparedness, and building or development codes.

Flood proofing can reduce flood damages by a combination of structural provisions and changes or adjustments to properties subject to flooding.

Examples of flood proofing are sealing low window and door openings and modifying floor drains to prevent the entrance of flood waters.

Flood warning systems should be coordinated with local disaster plans. The National Weather Service issues warnings of potential flood producing storms. Staff gages set at key locations can be monitored to give advance warnings. A float-activated electronic signal could be connected to the local police or fire station for monitoring.

Relocation involves permanent evacuation of developed areas subject to inundation, acquisition of lands by purchase, removal of improvements and relocation of the population from such areas. Such lands could be used for parks or other purposes that would not suffer large damages and would not interfere with floodflows.

Zoning is a legal method used to implement and enforce the details of the flood plain management program, to preserve property values, and to achieve the most appropriate and beneficial use of available land. Clear, concise, and thorough zoning bylaws with enforcement of the bylaws are essential to make zoning effective.

Flood insurance was established by the National Flood Insurance Act of 1968 (Public Law 90-448, as amended) to make limited amounts of flood insurance, which were previously unavailable from private insurers, available to property owners and occupiers. The Flood Disaster Protection Act of 1973 (Public Law 93-234, as amended) was a major expansion of the National Flood Insurance Program.

Flood insurance is available through local insurance agents and brokers only after a local governing body applies and is declared eligible for the program by the Federal Insurance and Hazard Mitigation Division of the Federal Emergency Management Agency (FEMA). Adoption and enforcement of a local flood prevention ordinance which meets FEMA minimum flood plain management criteria is necessary to qualify and maintain eligibility.

In those communities participating in the FEMA program, owners and occupiers of all buildings and mobile homes in the entire community are eligible to obtain flood insurance coverage. Where flood insurance is available, it is recommended that buildings and moble homes within or adjacent to the delineated flood hazard areas carry flood insurance on the structure and contents.

The City of Navasota and Grimes County are presently participating in the National Flood Insurance Emergency Program. Flood insurance is available through local insurance agents and brokers.

Emergency preparedness consists of a plan by local officials to be put into effect in the event of flooding. Procedures are worked out and personnel designated to implement the plan. Methods and procedures to alert and warn the populace of possible flooding are developed. High risk areas, handicapped, elderly or others known to need help during evacuation are located and identified. Plans are made for their evacuation or rescue. Shelters are provided for evacuees.

Building codes are developed to set up minimum standards for controlling the design, construction, and quality of materials used in buildings and structures within a given area to provide safety for life, health, property and public welfare. Building codes can be used to minimize structural and subsequent damages resulting from inundation. Building restriction codes can:

1. Specify adequate anchorage to prevent flotation of buildings from their foundations.

2. Establish basement elevations and minimum first-floor elevations in accordance with potential flood heights.

3. Prevent virtually all damage by elevating the foundation and prohibiting basements in those areas subject to very shallow and frequent flooding.

4. Require building reinforcement to withstand water pressure or high velocity flow and restrict the use of materials which deteriorate rapidly in the presence of water.

5. Prohibit equipment that might be hazarous to life when submerged. This includes chemical storage, boilers, and electrical equipment.

Development policies which are designed to prevent construction of streets and utility systems in flood prone areas tend to slow development of the flood plains.

STRUCTURAL MEASURES

Structural measures such as dams or channels were considered as a means of reducing flood losses. Channel improvement appears to be a viable alternative to reduce flood damages on the West Tributary of Sandy Creek. About 5,200 feet of channel work are needed on the West Tributary of Sandy Creek to alleviate flooding in this area. An economic analysis using the URB1 computer program shows that a favorable benefit-cost ratio can be obtained.

Channel improvement on Cedar Creek does not appear to be a viable alternative due to site conditions and existing development. Floodwater retarding dams do not appear to be feasible due to lack of favorable site locations.

SELECTED ALTERNATIVE

The alternative for reducing flood losses selected by the City of Navasota for immediate implementation is to contact the Federal Insurance and Hazard Mitigation Division of the Federal Emergency Management Agency (FEMA) and apply for inclusion in the Regular National Flood Insurance Program. The City will adopt and implement the flood plain management ordinances necessary to qualify for and maintain eligibility in the Regular National Flood Insurance Program.

Other alternatives listed in this report will be considered for later implementation.

FLOOD HAZARD MAPS

The index map (Appendix, page 9) shows the stream reach covered by each of the photomaps. The index map also shows the watershed boundaries and stream reaches studied.

The limits of the 100-year and 500-year frequency floods, for present conditions, were delineated on aerial photographs (Appendix, pages 11 to 33) to indicate the extent of area inundated. The 10-year and 50-year frequency floods for present conditions could not be effectively shown on the aerial photographs due to the map scale and topography. The flood lines shown are based on field surveys of roads, bridges, and valley sections used in conjunction with Geological Survey topographic maps having 10-foot contour intervals, and interpretation of aerial photographs. These maps should only be used to determine the approximate boundaries of the flood areas. Actual dimensions measured on the ground may vary slightly from those measured on the photomaps of this report due to map scale and reproduction limitations. The water surface profile elevations should be used to determine actual on the ground dimensions.

Flood elevations in this report are minimum elevations. Debris may collect at bridges and culverts and clog the channels during major floods and increase the depth of flooding. Analyses were made without showing the effects of potential obstructions. Also, extremely rare events such as catastrophic storms were not analyzed.

TECHNICAL APPENDIX

A technical appendix is included in this report. The index map, flood hazard area photomaps and flood profiles are included in the Appendix. The index map shows the study area coverage of individual flood hazard area maps and the watershed boundaries (Appendix, page 9).

The water surface profiles of Cedar Creek and West Tributary of Sandy Creek show the profiles of the 10-year, 50-year, 100-year, and 500-year frequency floods for present conditions. Included on the profiles are stream elevations of the channel bottom, pertinent bridge and roadway data, and other location data. The stationing of profile is bank full stream channel distance in feet and is based on measured distances from the 1976 flight of aerial photomaps. Flood depths can be estimated at any location on the stream reach from the water surface profiles. The water surface profiles are included in the Appendix, pages 35 to 51. They consist of Cedar Creek, pages 35 to 43; Cedar Creek Tributary 1, page 45; and West Tributary of Sandy Creek, pages 47 to 51. An index is included in the Appendix pages 6 to 7, to assist the user in relating the flood hazard area photomaps to the appropriate water surface profile.

Cross sections, representative of the streams studied, have been plotted to illustrate the shape of that stream and its flood plain. The 10-year, 50-year, 100-year, and 500-year floodwater surface elevations are shown on the plotted cross section to illustrate the effect of various flood depths (see Appendix, page 53).

The elevations, discharges and flood plain width of the 10-year, 50-year, 100-year and 500-year floods at surveyed cross sections are shown in Appendix Table 2. Each cross section is listed by number on this table. Each cross section is also identified by number on flood hazard area photomaps. The user can locate a cross section on the photomap, turn to Table 2, (Appendix, pages 55 to 58) and read the discharge, elevation, and flood plain width directly from the table.

Also, included in the Appendix is a list of elevation reference marks showing the elevation and location of each. Additional data are on file in the USDA Soil Conservation Service State Office, W.R. Poage Federal Building, 101 South Main Street, Temple, Texas 76501-7682.

GLOSSARY

Channel -- A natural stream that conveys water; a ditch or channel excavated for the flow of water.

Channel Bottom -- The elevation of the deepest part of a stream channel at a particular cross section.

Channel Modification -- The modification of the flow characteristics of a channel by clearing, excavation, realignment, lining, or other means to increase its capacity; sometimes used to connote channel stabilization.

Flood -- An overflow or inundation that comes from a river or other body of water and causes or threatens damage.

Flood Frequency -- A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative stream flow or rainfall and runoff records. A 10-year frequency flood would have an average frequency of occurrence in the order of once in 10 years (a ten percent chance of being equalled or exceeded in any given year). A 50-year frequency flood would have an average frequency of occurrence in the order of once in 50 years (a two percent chance of being equalled or exceeded in any given year). A 100-year frequency flood would have an average frequency of occurrence in the order of once in 100 years (a one percent chance of being equalled or exceeded in any given year). A 500-year frequency flood would have an average frequency of occurrence in

the order of once in 500 years (a 0.2 percent chance of being equalled or exceeded in any given year).

Flood Peak -- The highest value of the stage or discharge attained by a flood, thus, peak stage or peak discharge.

Flood Plain -- 1. Nearly level land situated on either or both sides of a channel which is subject to overflow flooding. 2. Lowland and relatively flat alluvial areas adjoining inland and coastal waters (streams, bays, etc.), including flood-prone areas of off shore islands.

500-Year Flood Plain -- The land that would be flooded on an average of once every 500 years.

100-year Flood Plain -- The land that would be flooded on an average of once every 100 years.

Flood Profile -- A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage -- The stage at which overflow of the natural banks of a stream begins to cause damage in the reach in which the elevation is measured.

High Water Mark (HWM) -- The maximum observed and recorded height or elevation that floodwater reaches during a storm, usually associated with the flood peak. The high water mark may be referenced to a particular building, bridge or other landmark, or based on debris deposits on bridges, fences, or other evidence of the flood.

Low Bank -- The highest elevation of a specific channel cross section at which the water will be contained without overflowing onto adjacent flood plain areas.

Runoff -- That portion of the precipitation on a drainage area that is discharged from the area in stream channels; types include surface runoff, groundwater runoff, or seepage.

Structural Bottom of Opening -- The lowest point of a culvert or bridge opening with a constructed bottom through which a stream flows that could tend to limit the stream channel bottom to that specific elevation. This structural bottom may be covered with sediment or debris which further restricts the size of the opening.

Top of Opening -- The lowest point of a bridge, culvert, or other structure over a river, stream or watercourse that limits the height of the opening through which water flows. This is referred to as "low steel" or "low chord" in some regions.

Water Surface Profile -- A graph showing the relationship of water surface elevation to stream channel location for a specific flood event.

Watershed -- All land and water within the confines of a drainage divide.

Watershed Boundary -- The divide separating one drainage basin from another.

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TECHNICAL APPENDIX

This Technical Appendix to the Cedar Creek and West Tributary of Sandy Creek Flood Plain Management Study Report is a compilation of the FPMS technical findings. It includes the photomap index, flood hazard area photomaps, flood profiles, plottings of typical stream cross sections, elevation and discharge tabulations and a listing of pertinent elevation reference marks. Other technical data developed during this study are on file in the USDA Soil Conservation Service State Office, W.R. Poage Federal Building, 101 South Main Street, Temple, Texas 76501-7682.

INVESTIGATIONS AND ANALYSES

FIELD SURVEYS

Topographic data were obtained from Geological Survey topographic maps and field surveys. Engineering surveys were made of cross sections selected to represent the stream hydraulics and flood plain areas (refer to the sheets of typical valley cross section, Appendix, page 53). Elevations appearing in this report are based on mean National Geodetic Vertical Datum of 1929. Temporary elevation reference marks were established by Soil Conservation Service surveyors in 1983-1984. Table 3 Appendix, pages 59 to 63, shows the listings, descriptions, and location of permanent and temporary elevation reference marks.

HYDROLOGIC AND HYDRAULIC METHODS

The Cedar Creek and West Tributary of Sandy Creek watershed boundaries were determined by use of Geological Survey topographic maps. The top of the

watershed begins approximately 1.5 miles northeast of the Navasota city limits in Grimes County. Hydraulic evaluations were based on synthetic frequency methods. Rainfall frequency data were obtained from Weather Bureau Technical Paper No. 40, Rainfall Frequency Atlas of the United States. Values greater than the 100-year frequency event were determined by extrapolation of the rainfall versus frequency graph. Peak discharge values were determined by flood routing various storm frequencies with a 24-hour rainfall duration using SCS Technical Release No. 20, A Computer Program for Project Formulation, Hydrology. The program computes surface runoff resulting from any synthetic or natural rainstorm. The program will route the flow through stream channels and reservoirs. Results include, but are not limited to, a combination of the routed hydrograph with those from other tributaries and a printout of the peak discharges, their time of occurrence, and the water surface elevations for each computed discharge at any desired cross section or structure.

Geological Survey Water Resources Investigations 77-110 Open File Report "Technique or Estimating the Magnitude and Frequency of Floods in Texas" was used to develop peak discharges for comparison purposes only since it has no procedure for evaluating the effects of watershed structural improvements.

From the representative stream and road cross sections, water surface profiles were developed by the Modified Slope Area Method. The effects of bridges and culverts on the stream hydraulics were determined by use of the Bureau of Public Roads (BPR) Method. Computations were made using SCS's

"WSP2, A Computer Program for Determining Flood Elevations and Flood Areas for Certain Flow Rates".

Using the output data from this program, rating curves were plotted for each cross section. These curves show the relationship between stage or elevation and discharge. Water surface profiles were developed from these rating curves and the computer results of TR-20 routings.

FLOOD HAZARD EVALUATION

The 500-year and 100-year frequency flood hazard areas are outlined on aerial photographs obtained from the 1976 Texas Department of Highways and Public Transportation flight. The flood hazard area boundaries were developed by plotting the computed water surface elevations on the surveyed cross sections and transposing this information to the aerial photographs. The flood hazard areas between the surveyed cross sections were developed through interpretation of Geological Survey topographic maps and the aerial photographs in conjunction with the surveyed cross sections. Actual flood limits may vary slightly on the ground from the outlined area on the photomaps due to map scale and reproduction limitations. For this reason, the water surface elevations from the flood profiles should be used for determining site specific potential flood depths.

ESTIMATES OF FLOOD LOSSES

The Urban Floodwater Damage Economic Evaluation computer application program (URB1) was used to compute average annual damages to buildings and contents. The program requires as input data percent damage factors

(COF-DAMG) by flood depth for buildings and contents of representative houses or other types of buildings.

The URB1 computer application program locates each house to be evaluated, between cross sections, by means of stationing along a common base line and by elevations at which damage begins. The damage to each house, or other type of building, is computed based on the frequency and depth of floods related to the damage factor for the type of house involved. Damages and benefits are summarized for each cross section for each reach and alternative.

INVENTORY OF NATURAL VALUES

The natural values of the Cedar Creek and West Tributary of Sandy Creek flood plain were determined by the Soil Conservation Service staff biologist through on the ground reconnaissance, interviews of local people and literature search.

PUBLIC PARTICIPATION

The Cedar Creek and West Tributary of Sandy Creek Flood Plain Management Study Plan of Work was developed through consultation with the local officials and study endorsers.

A public meeting was held during preparation of the report draft in order to get public input and participation.

MANAGEMENT ALTERNATIVES

Nonstructural management alternatives were considered during the flood plain management study and discussed during meetings with local public officials and other interested members of the public. Those considered to have merit and worthy of further study for possible implementation were put in the report.

A structural measure consisting of channel modification of the West Tributary of Sandy Creek was studied to determine its effect on flooding and the feasibility of construction. Detailed studies were not made, but cost estimates were developed. If this alternative is selected, additional detailed investigations and planning will be needed in order to implement this alternative.

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CEDAR CREEK AND THE WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY

FLOOD HAZARD AREA PHOTOMAPS
AND
WATER SURFACE PROFILES

Cross Section Number	Flood Hazard Area Photomap Sheet Number	Water Surface Profile Sheet Number	Cross Section Number	Flood Hazard Area Photomap Sheet Number	Water Surface Profile Sheet Number
CEDAR CREEK					
1	11	1	21	7, 8	3
2	11	1	22	7, 8	3
3	12	2	23	7, 8	3
4	8, 12	2	24	7, 8	3
5	8, 12	2	25	7, 8	3
6	8, 12	2	26	7, 8	3
7	8, 12	2	27	3, 7, 8	4
8	8	3	28	7	4
9	8	3	29	7	4
10	8	3	30	7	4
11	8	3	31	2, 7	4
12	8	3	32	2, 6, 7	4
13	8	3	33	1, 2, 6, 7	4
14	8	3	34	1, 2, 6, 7	4
15	8	3	35	1, 2	5, 6
16	8	3	36	1	5
17	7, 8	3	37	1	5
18	7, 8	3	38	1	5
19	7, 8	3	39	1, 2	5
20	7, 8	3			

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TO

CEDAR CREEK AND THE WEST TRIBUTARY OF SANDY CREEK
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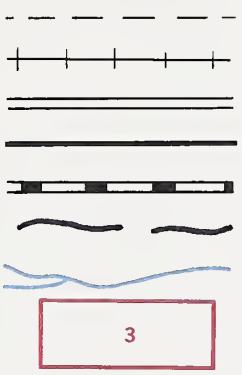
Cross Section Number	Flood Hazard Area Photomap Sheet Number	Water Surface Profile Sheet Number
CEDAR CREEK TRIBUTARY 1		
40	1	6
41	1	6
42	1	6
43	1	6
WEST TRIBUTARY OF SANDY CREEK		
44	5, 10	7
45	5, 10	7
46	5, 9, 10	7
47	4, 5, 9, 10	7
48	4, 5, 9, 10	7
49	4, 5, 9	7
50	4, 5, 9	7
51	4, 5, 9	7
52	4, 5, 9	7
53	4, 5, 9	7
WEST TRIBUTARY OF SANDY CREEK (Cont'd)		
54	4, 9	8
55	4, 9	8
56	4, 9	8
57	4, 9	8
58	3, 4, 8, 9	8
59	3, 4, 8, 9	8
60	3, 4, 8, 9	8
61	3, 4	8
62	3	9
63	3	9
64	3	9
65	3	9
66	3	9

LEGEND



CITY LIMIT
RAILROAD
DIVIDED HIGHWAY
STATE HIGHWAY
FARM TO MARKET ROAD
WATERSHED BOUNDARY
STREAM CHANNEL STUDY REACH
PHOTOMAP COVERAGE

INDEX MAP

FLOOD PLAIN MANAGEMENT STUDY AREA CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK

GRIMES COUNTY, TEXAS

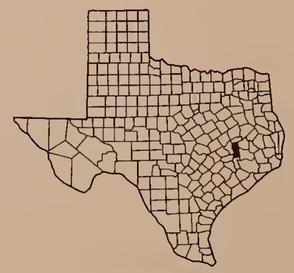
APPROXIMATE SCALE - MILES

APPROXIMATE SCALE - KILOMETERS

AUGUST 1985 4-R-38588

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



VICINITY MAP

LEGEND

- CITY LIMIT
- RAILROAD
- DIVIDED HIGHWAY
- STATE HIGHWAY
- FARM TO MARKET ROAD
- WATERSHED BOUNDARY
- STREAM CHANNEL STUDY REACH
- PHOTOMAP COVERAGE

3

INDEX MAP

FLOOD PLAIN MANAGEMENT STUDY AREA CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK

GRIMES COUNTY, TEXAS

0 1 2 3

APPROXIMATE SCALE - MILES

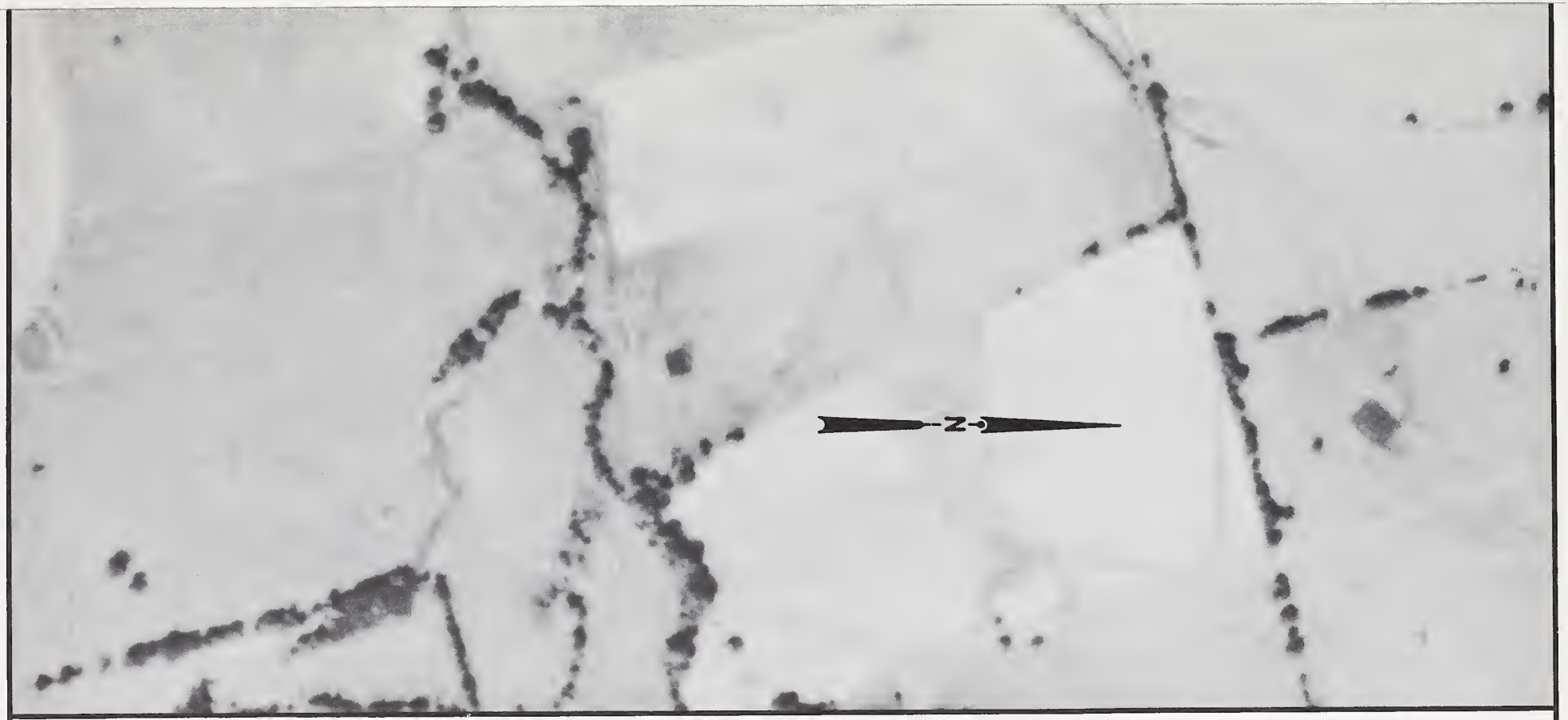
0 1 2 3 4

APPROXIMATE SCALE - KILOMETERS

SOURCE: COUNTY HIGHWAY MAP POLYCONIC PROJECTION

USDA-SCS NATIONAL CARTOGRAPHIC CENTER FT. WORTH, TX 1985

AUGUST 1985 4-R-38588



LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Cross Section Location
- Stream Channel
- X — Elevation Reference Marks
- 1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

1976 Texas Highway Department Photography

SHEET 1 OF 12

U.S. DEPARTMENT OF AGRICULTURE
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CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

FLOOD HAZARD AREA

CEDAR CREEK

LEGEND

100 Year Flood Hazard Area
500 Year Flood Hazard Area
Cross Section Location
Stream Channel
Elevation Reference Marks
1400 → Channel Station

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SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

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FLOOD HAZARD AREA

CEDAR CREEK

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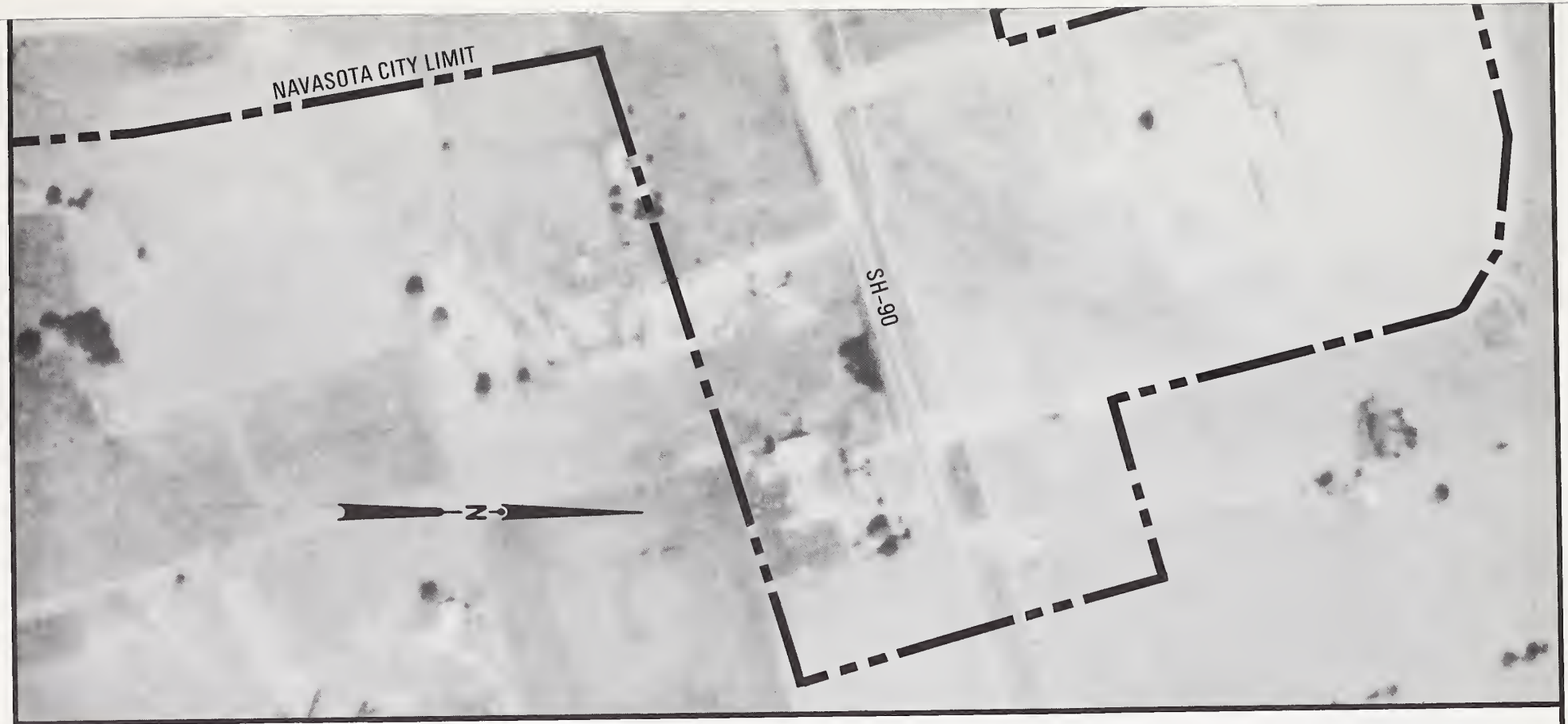

LEGEND

100 Year Flood Hazard Area

500 Year Flood Hazard Area

Cross Section Location

Stream Channel

X Elevation Reference Marks

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SCALE 0 400 800 FEET

0 100 200 METERS

APPROXIMATE

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FLOOD HAZARD AREA

CEDAR CREEK

LEGEND

100 Year Flood Hazard Area

500 Year Flood Hazard Area

Cross Section Location

Stream Channel

Elevation Reference Marks

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SCALE 0 400 800 FEET

0 100 200 METERS

APPROXIMATE

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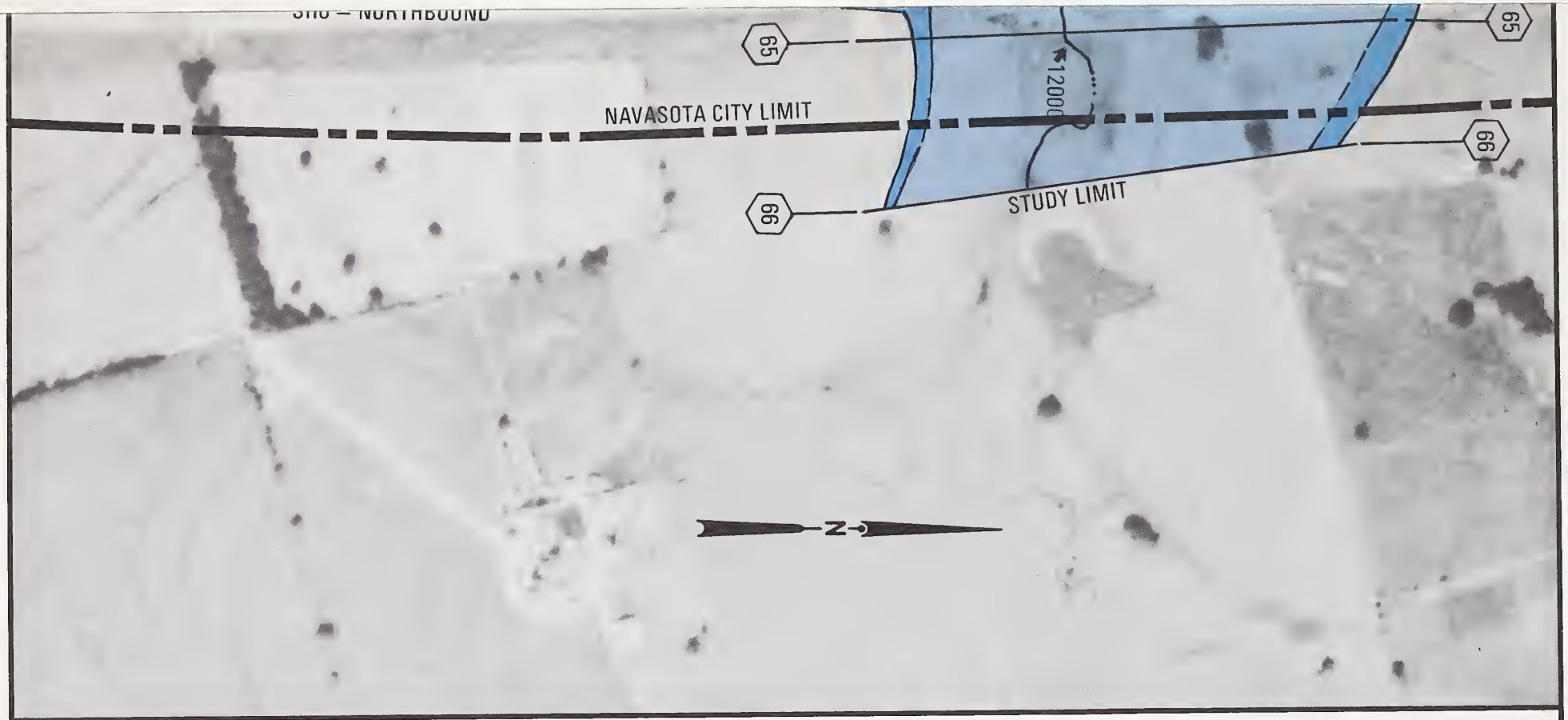
FLOOD HAZARD AREA

CEDAR CREEK

USDA SCS FORT WORTH, TEXAS 1985



LEGEND

100 Year Flood Hazard Area

500 Year Flood Hazard Area

Cross Section Location

Stream Channel

X Elevation Reference Marks

1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 400 800 FEET

0 100 200 METERS

APPROXIMATE

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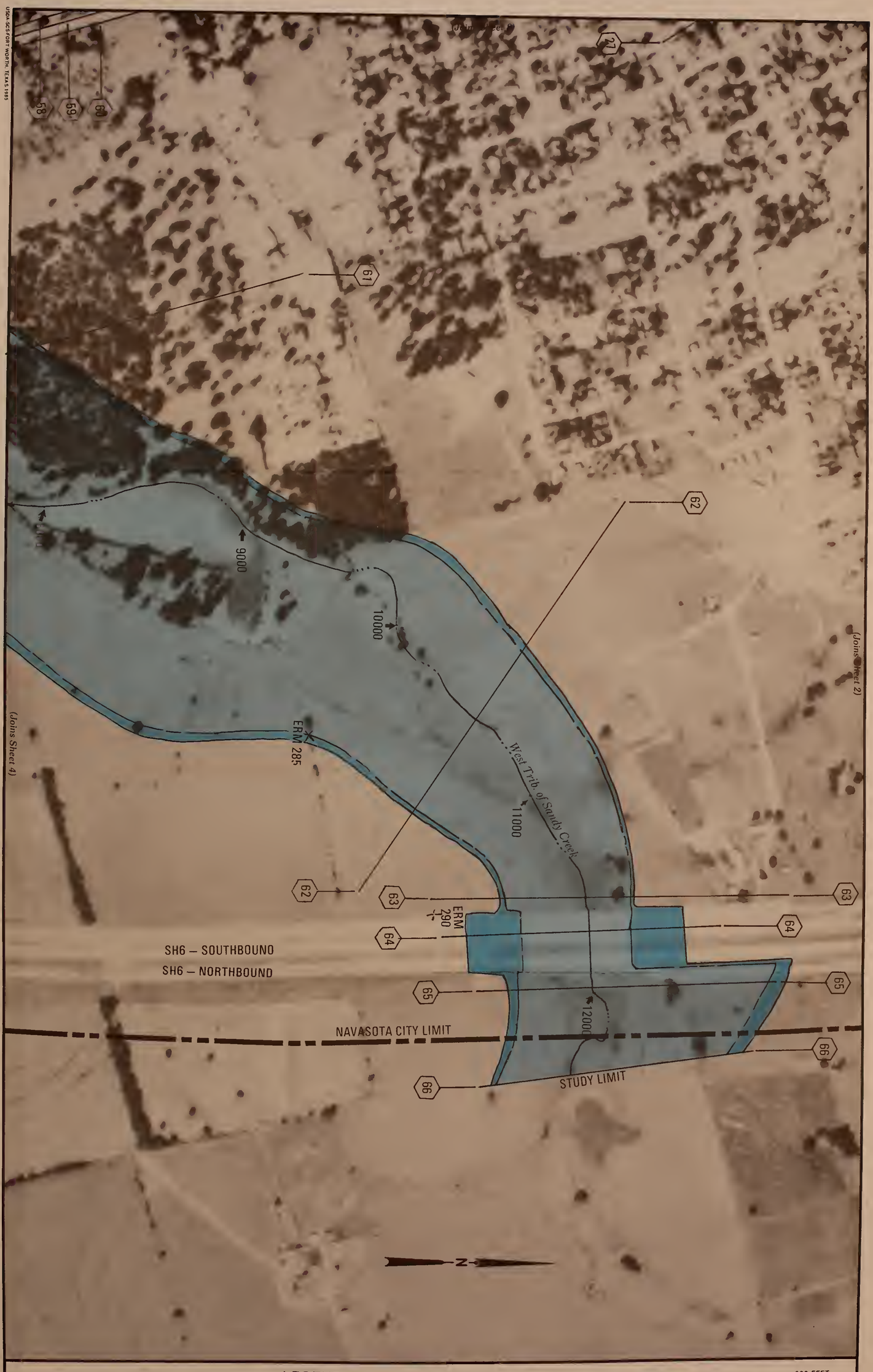
FLOOD HAZARD AREA

West Tributary of Sandy Creek



LEGEND

100 Year Flood Hazard Area
500 Year Flood Hazard Area
Cross Section Location
Stream Channel
Elevation Reference Marks
1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

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FLOOD HAZARD AREA

West Tributary of Sandy Creek

LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
- Cross Section Location
- Stream Channel
- X Elevation Reference Marks
- 1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

1976 Texas Highway Department Photography

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FLOOD HAZARD AREA

West Tributary of Sandy Creek

LEGEND

- 100 Year Flood Hazard Area
- 500 Year Flood Hazard Area
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- Stream Channel
- Elevation Reference Marks
- 1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

1976 Texas Highway Department Photography

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FLOOD HAZARD AREA

West Tributary of Sandy Creek

USDA-SCS-FORT WORTH, TEXAS 1983

LEGEND

100 Year Flood Hazard Area

500 Year Flood Hazard Area

Cross Section Location

Stream Channel

X Elevation Reference Marks

1400 Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 400 800 FEET
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APPROXIMATE

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West Tributary of Sandy Creek

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LEGEND

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- Stream Channel
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Limits of flooding may vary from actual location on the ground.

SCALE 0 400 800 FEET
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APPROXIMATE

1976 Texas Highway Department Photography

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West Tributary of Sandy Creek

USDA SCS FORT WORTH, TEXAS 1985

LEGEND

100 Year Flood Hazard Area

500 Year Flood Hazard Area

Cross Section Location

Stream Channel

Elevation Reference Marks

1400 → Channel Station

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SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

1976 Texas Highway Department Photography

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CEDAR CREEK

LEGEND

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SCALE 0 400 800 FEET
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1976 Texas Highway Department Photography

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CEDAR CREEK

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SCALE 0 400 800 FEET
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APPROXIMATE

1976 Texas Highway Department Photography

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FLOOD HAZARD AREA

CEDAR CREEK

LEGEND

- 100 Year Flood Hazard Area
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SCALE 0 400 800 FEET
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APPROXIMATE

1976 Texas Highway Department Photography

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FLOOD HAZARD AREA

CEDAR CREEK

LEGEND

- 100 Year Flood Hazard Area
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SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

1976 Texas Highway Department Photography

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FLOOD HAZARD AREA

CEDAR CREEK

LEGEND

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1976 Texas Highway Department Photography

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FLOOD HAZARD AREA

CEDAR CREEK

LEGEND

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- Stream Channel
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SCALE 0 400 800 FEET
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APPROXIMATE

1976 Texas Highway Department Photography

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FLOOD HAZARD AREA

West Tributary of Sandy Creek

USDA-SCS-FORT WORTH, TEXAS-1985

LEGEND

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APPROXIMATE

1976 Texas Highway Department Photography

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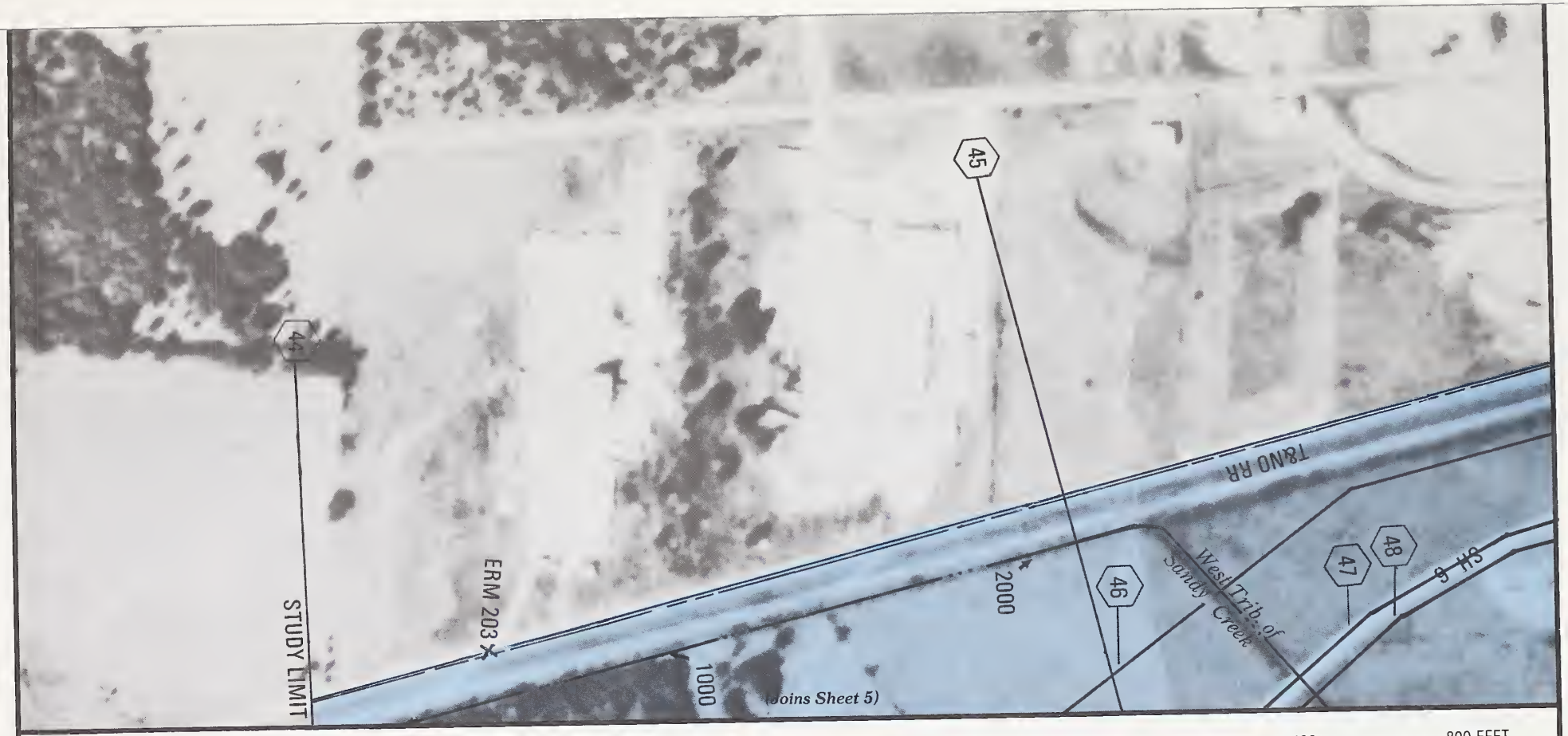
FLOOD HAZARD AREA

West Tributary of Sandy Creek



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1976 Texas Highway Department Photography

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FLOOD HAZARD AREA

West Tributary of Sandy Creek

SHEET 10 OF 12

USDA-SCS FORT WORTH, TEXAS 1983

LEGEND

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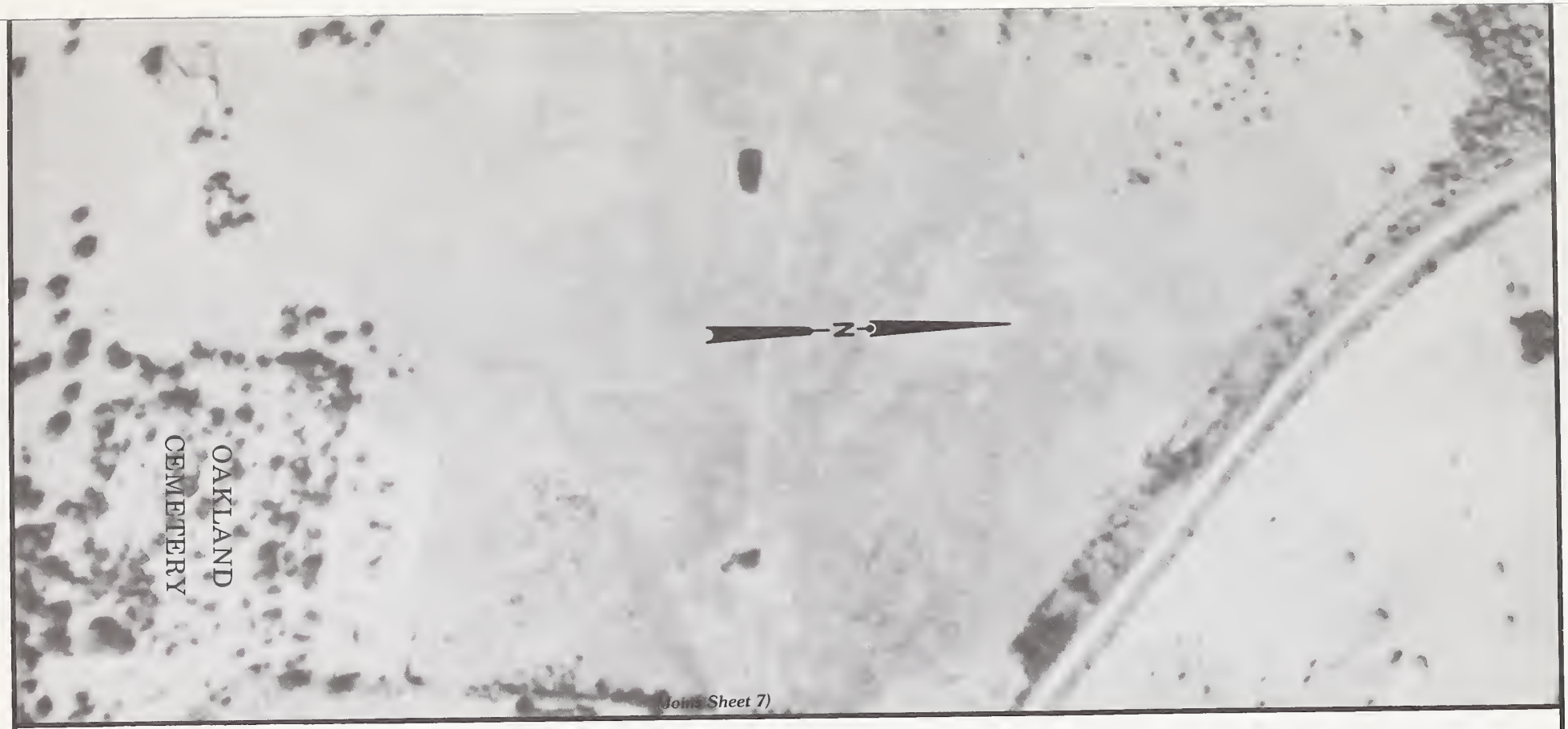
West Tributary of Sandy Creek



LEGEND

100 Year Flood Hazard Area

500 Year Flood Hazard Area

Cross Section Location

Stream Channel

X Elevation Reference Marks

1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

1976 Texas Highway Department Photography

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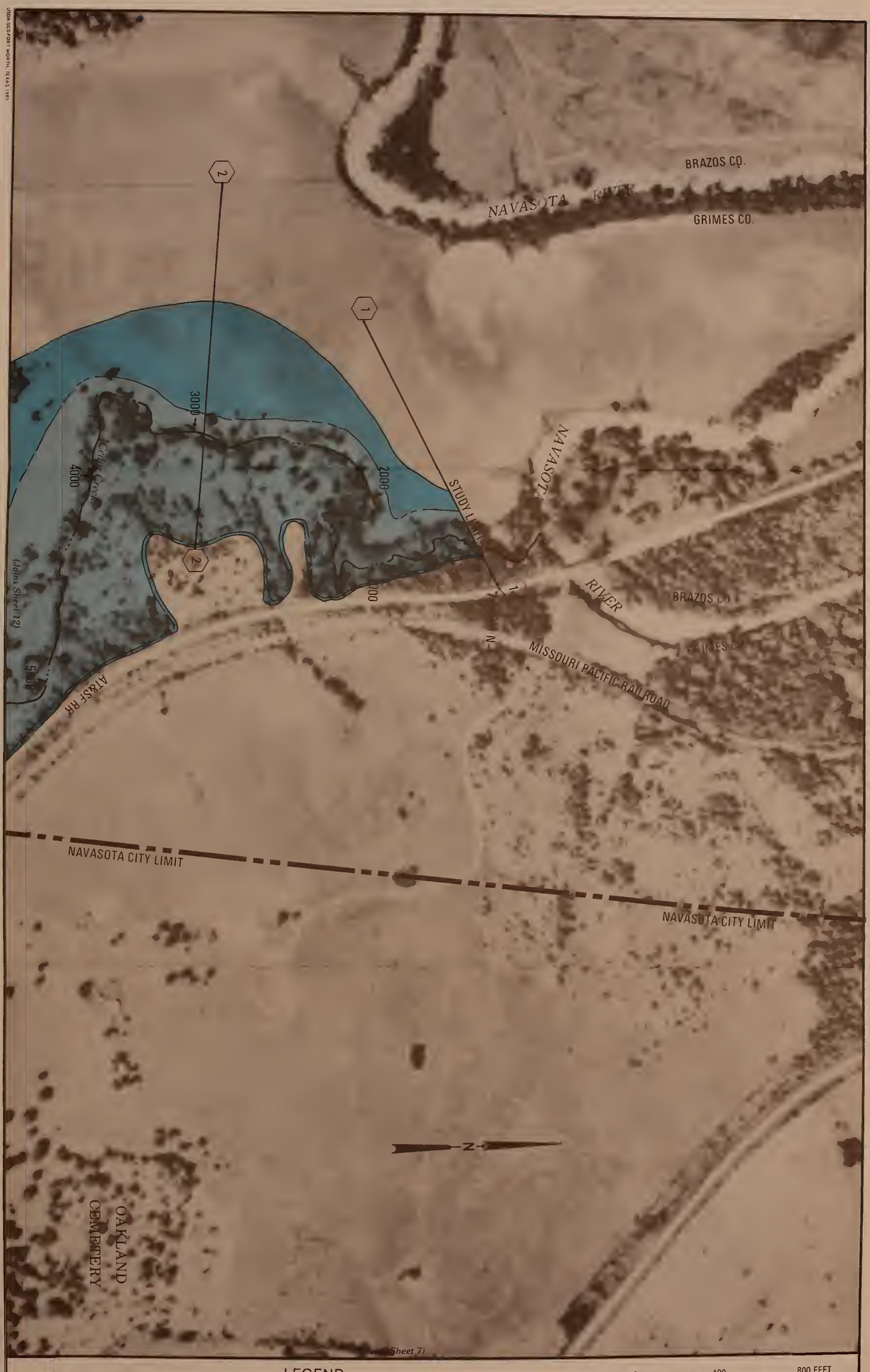
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

FLOOD HAZARD AREA

CEDAR CREEK



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1976 Texas Highway Department Photography

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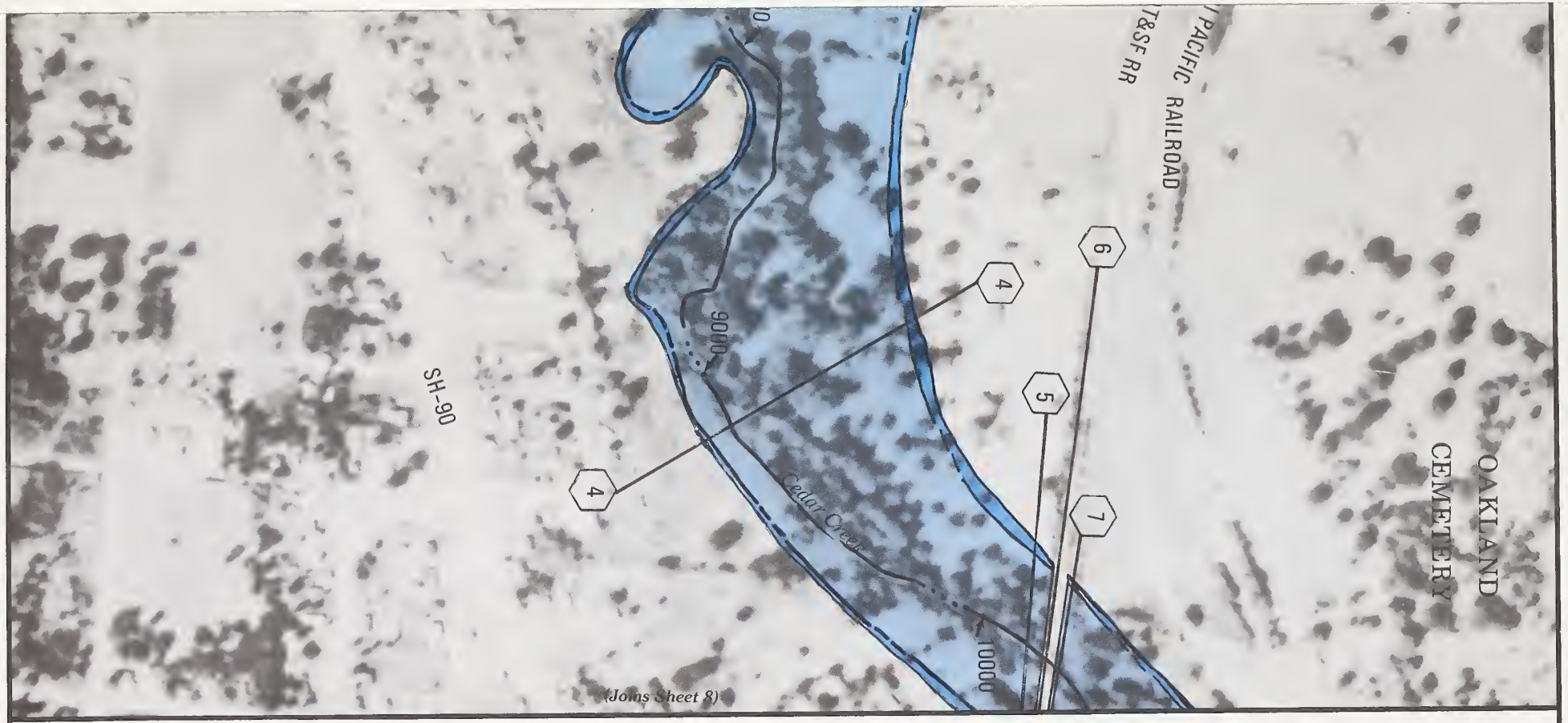
FLOOD HAZARD AREA

CEDAR CREEK

USDA-SCS FORT WORTH, TEXAS 1985



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APPROXIMATE

1976 Texas Highway Department Photography

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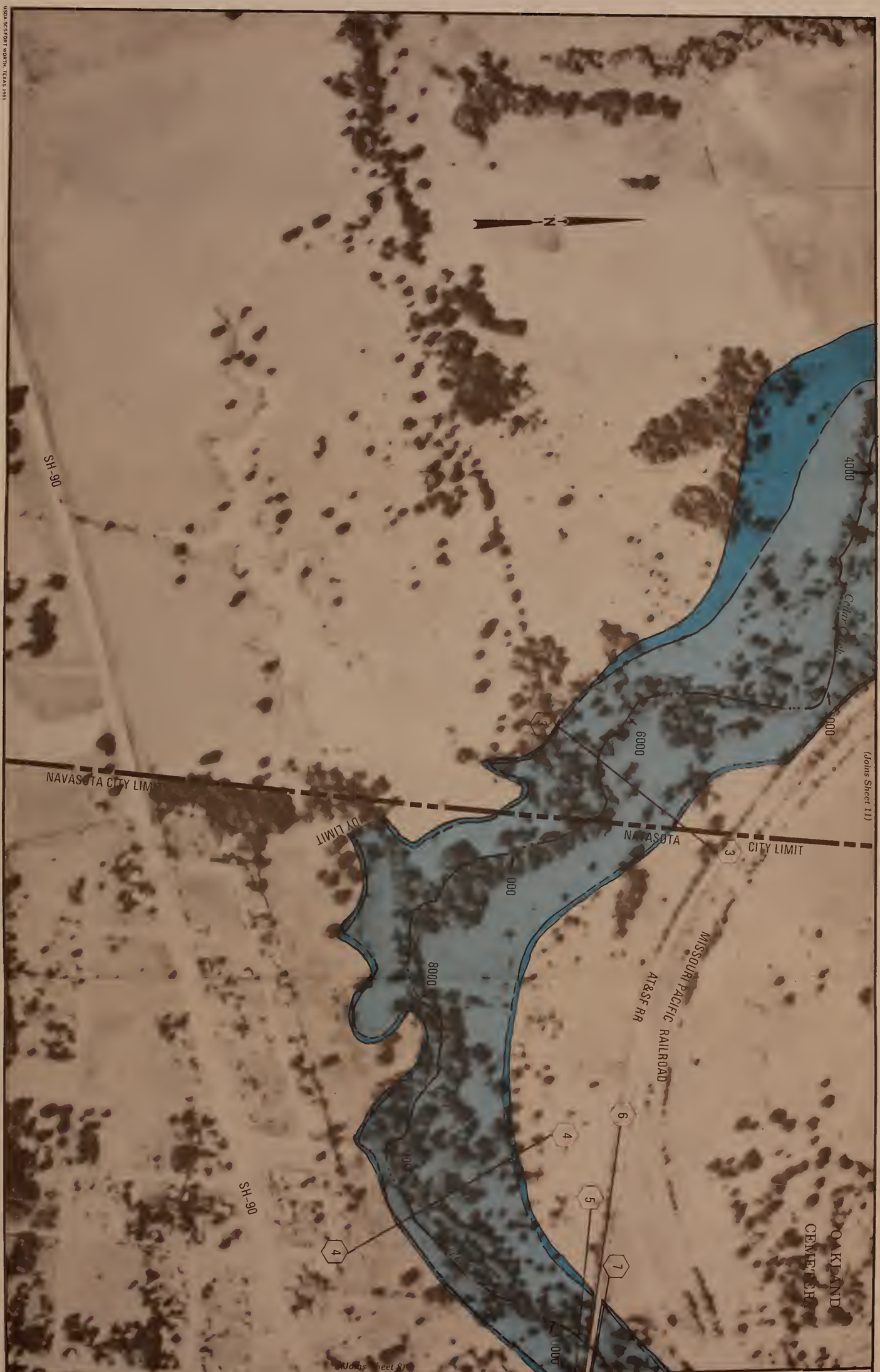
FLOOD HAZARD AREA

CEDAR CREEK

USDA-SCS-FORT WORTH, TEXAS-1983



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- 500 Year Flood Hazard Area
- Cross Section Location
- Stream Channel
- X Elevation Reference Marks
- 1400 → Channel Station

Limits of flooding may vary from actual location on the ground.

SCALE 0 400 800 FEET
0 100 200 METERS
APPROXIMATE

1976 Texas Highway Department Photography

SHEET 12 OF 12

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

FLOOD HAZARD AREA

CEDAR CREEK

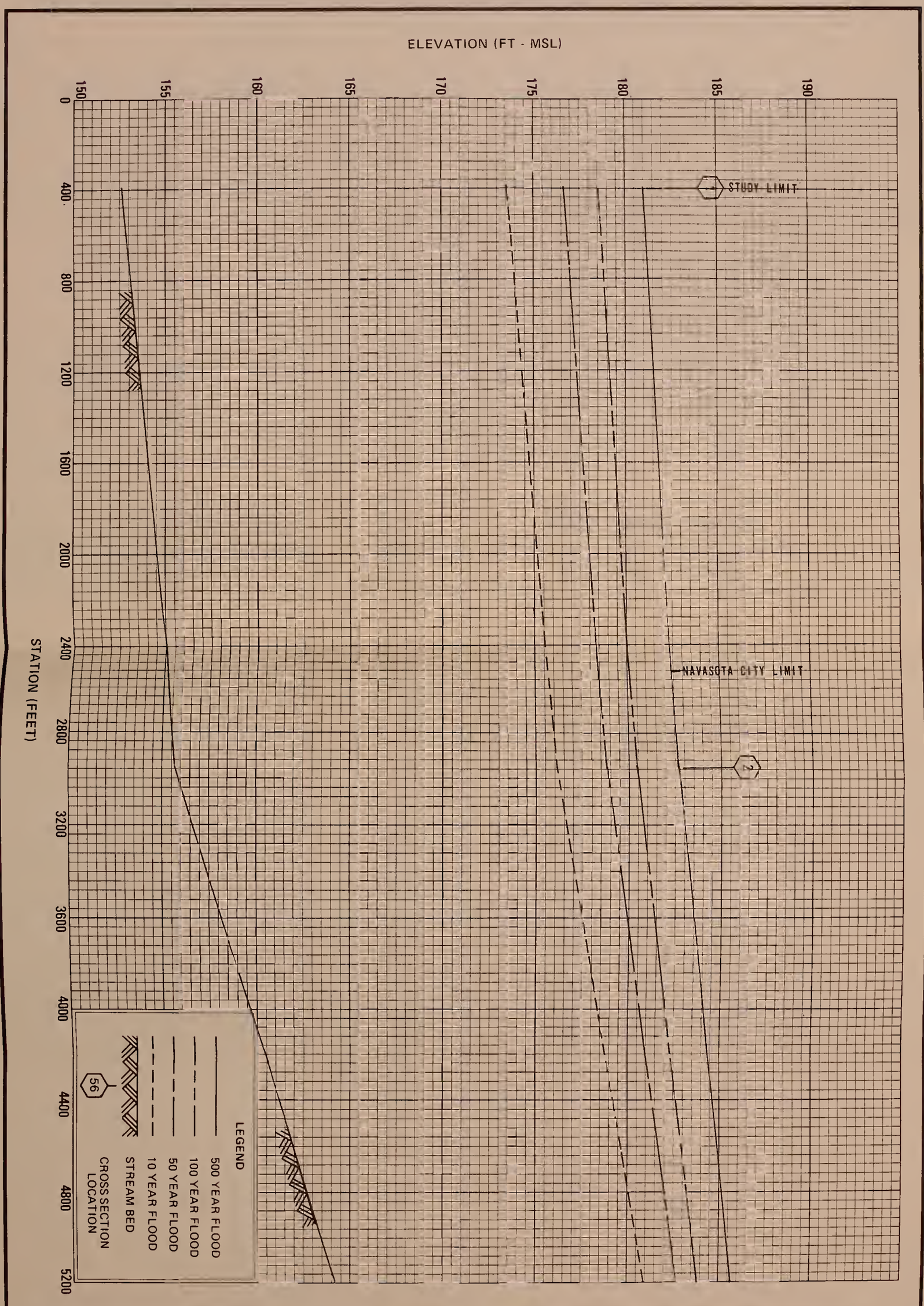
CEDAR CREEK

WATER SURFACE PROFILES

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

SHEET 1 OF 9



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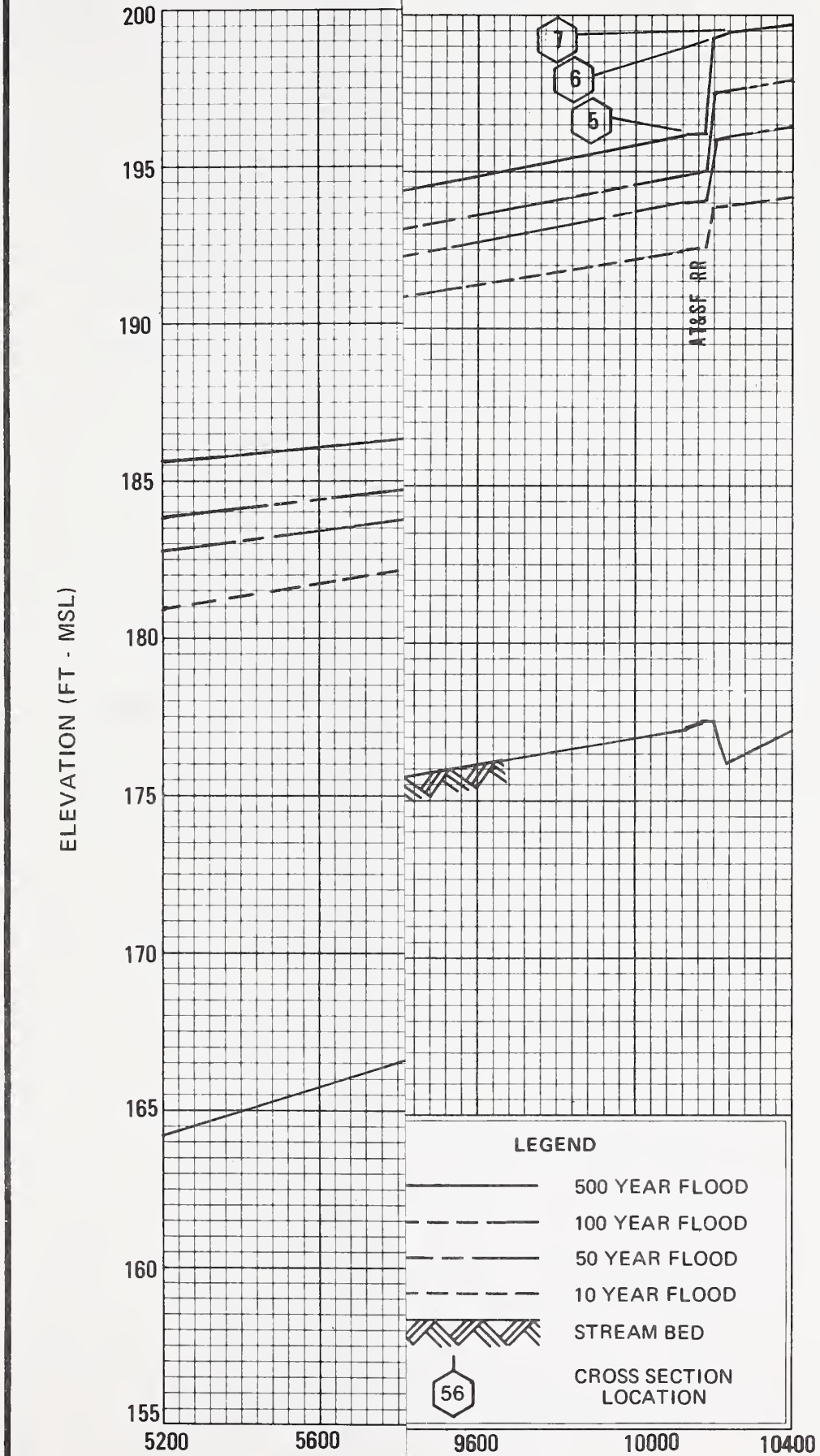
SOIL CONSERVATION SERVICE

CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

WATER SURFACE PROFILES

CEDAR CREEK

SHEET 1 OF 9



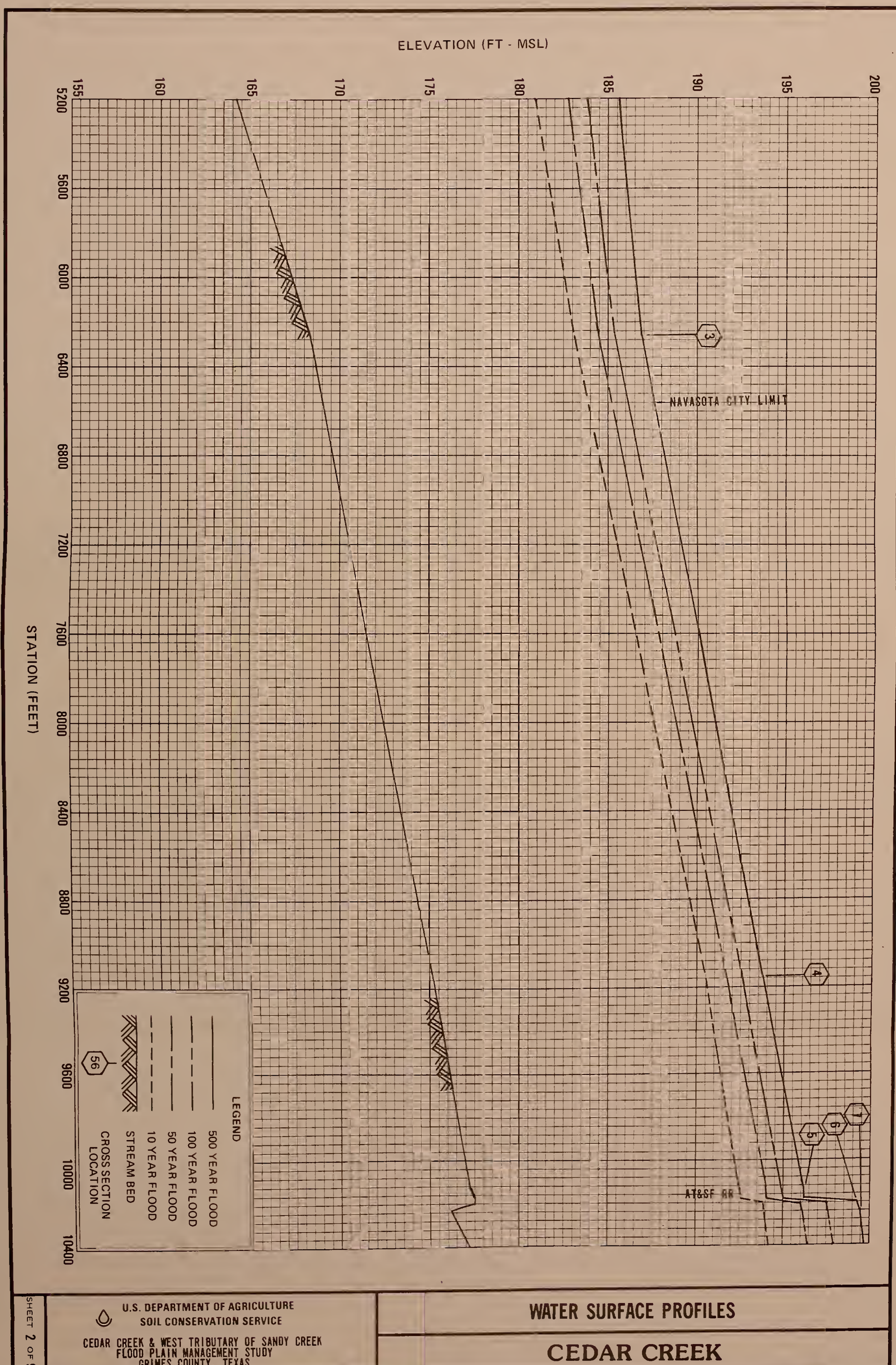
WATER SURFACE PROFILES

CEDAR CREEK

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

SHEET 2 OF 9



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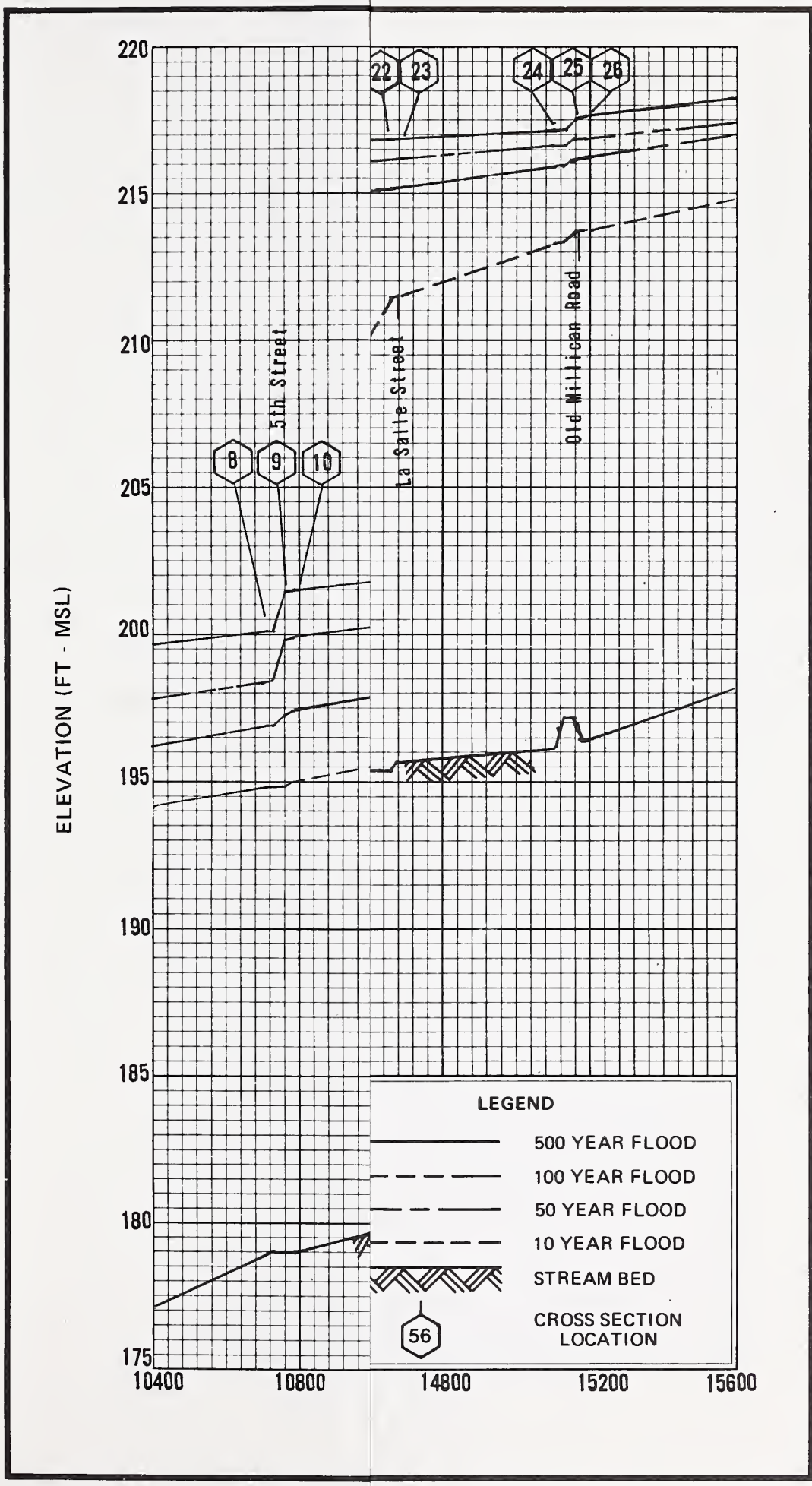
CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

WATER SURFACE PROFILES

CEDAR CREEK

SHEET 2 OF 9



WATER SURFACE PROFILES

CEDAR CREEK

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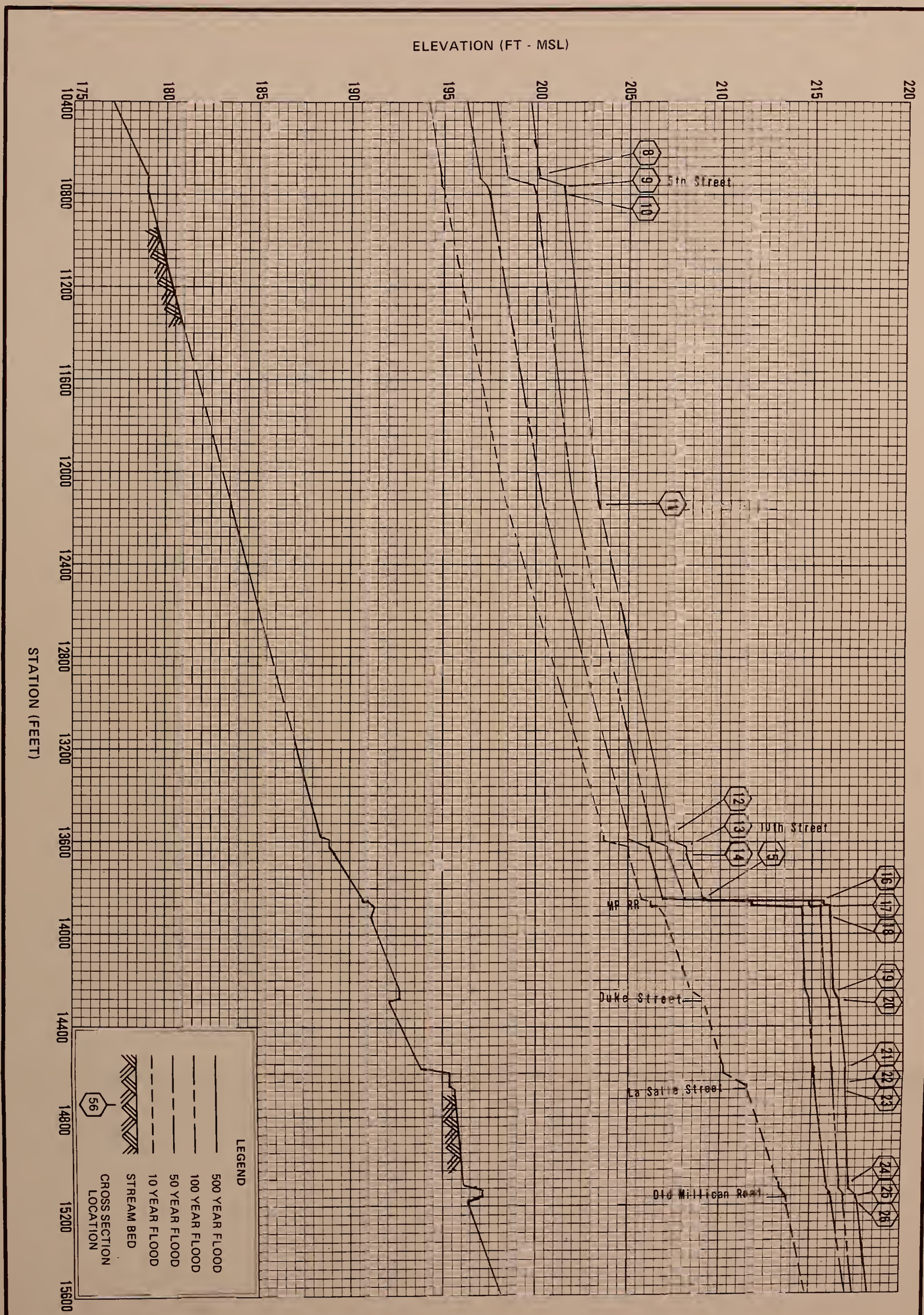
SOIL CONSERVATION SERVICE

CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

SHEET 3 OF 9



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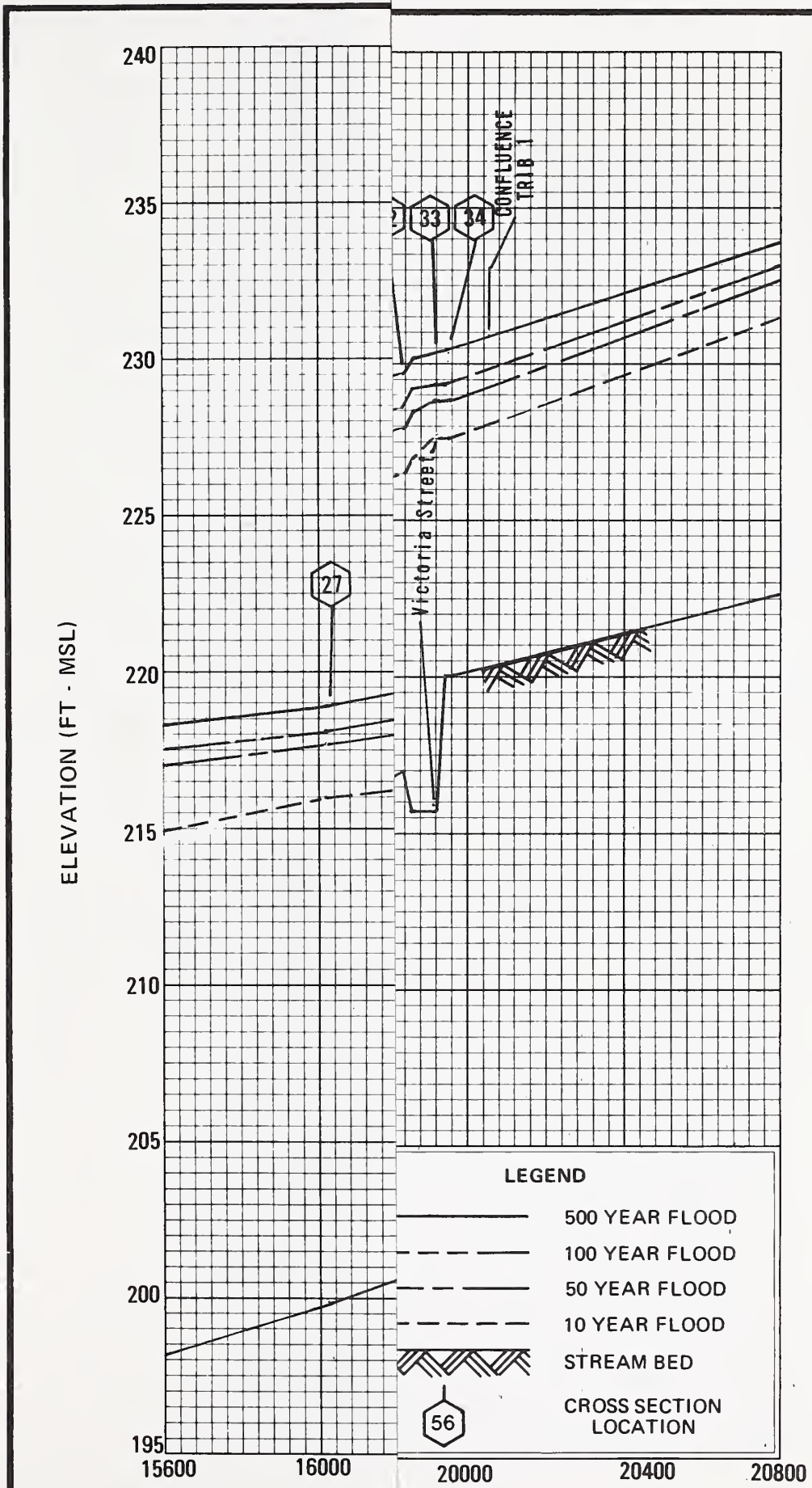
SOIL CONSERVATION SERVICE

CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

WATER SURFACE PROFILES

CEDAR CREEK

SHEET 3 OF 9



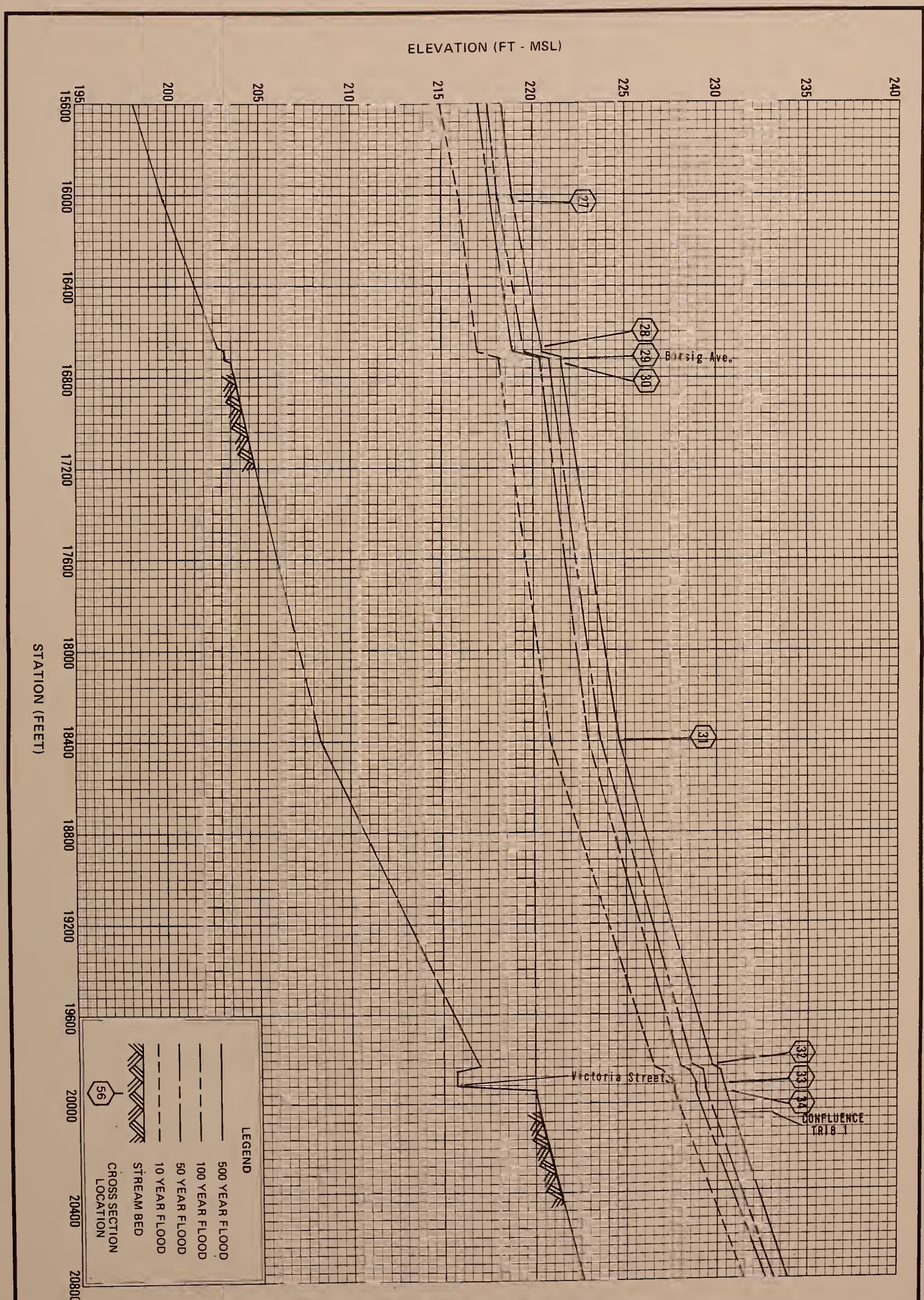
WATER SURFACE PROFILES

CEDAR CREEK

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

SHEET 4 OF 9



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FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

WATER SURFACE PROFILES

CEDAR CREEK

SHEET 4 OF 9

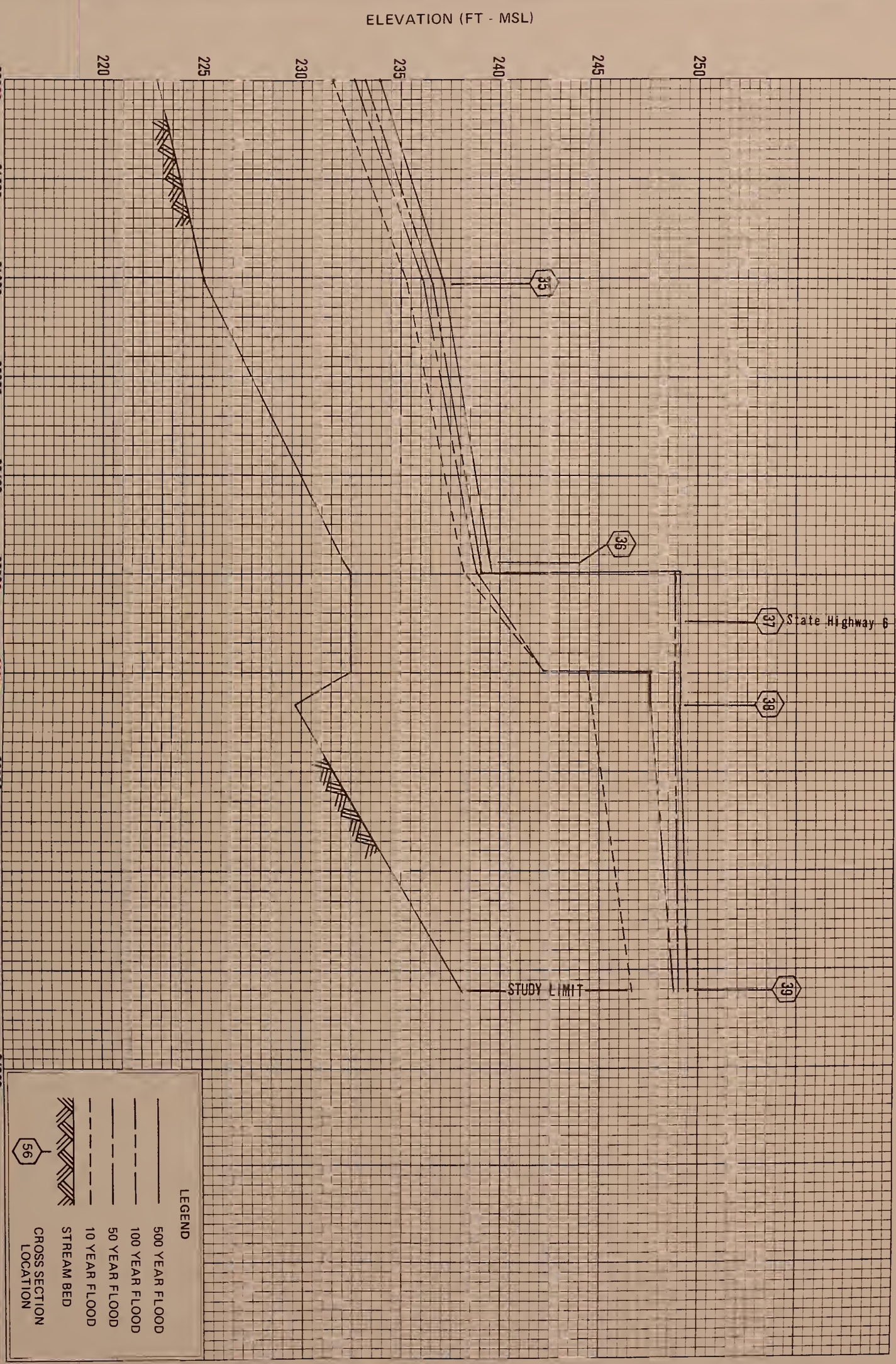
CEDAR CREEK

WATER SURFACE PROFILES

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

SHEET 5 OF 9



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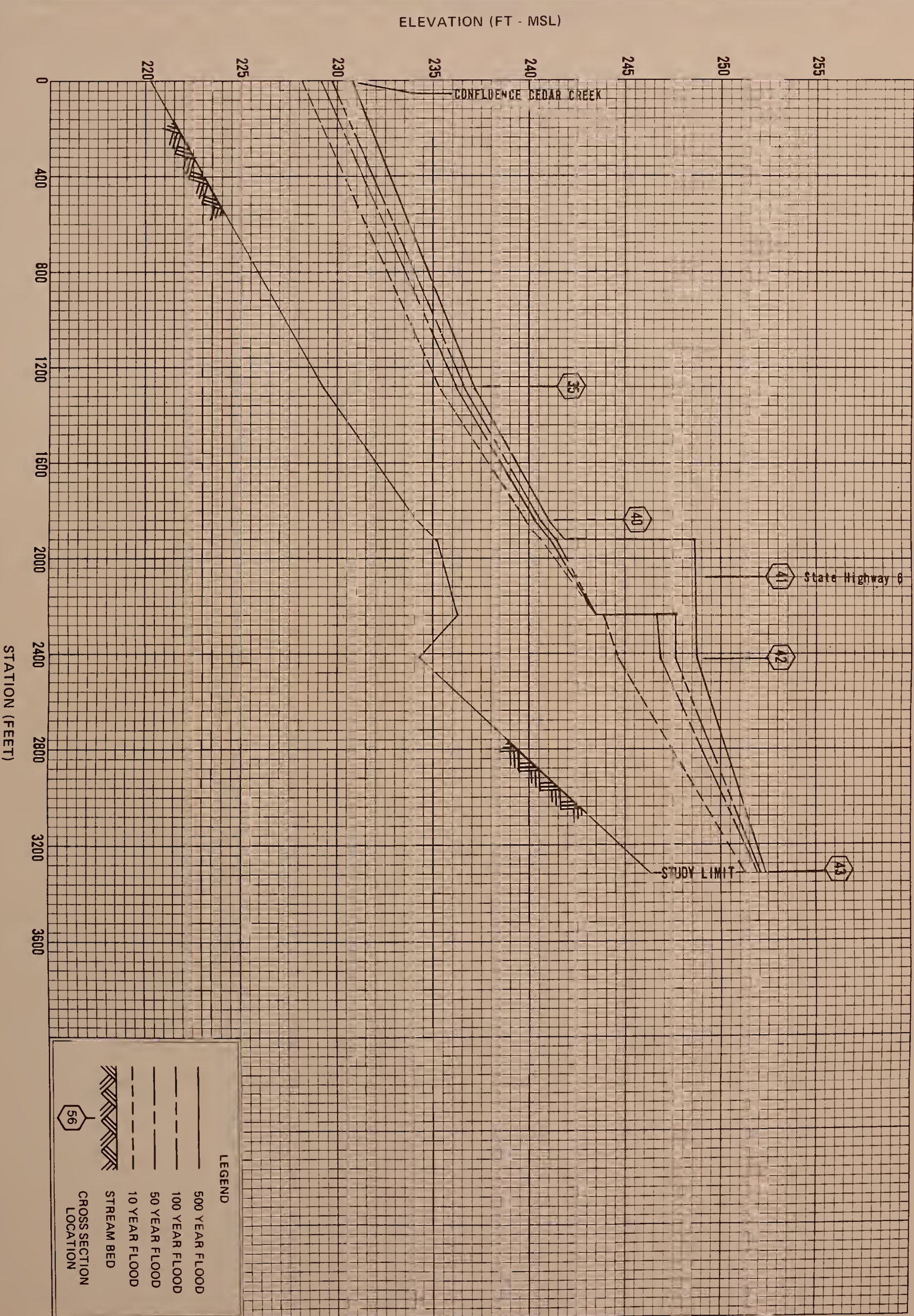
CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

WATER SURFACE PROFILES

CEDAR CREEK

SHEET 5 OF 9

ELEVATION (FT - MSL)
255
250
245
240
235
230
225
220
0
400
CONFLUENCE CEDAR CREEK
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
56
CROSS SECTION LOCATION
WATER SURFACE PROFILES
CEDAR CREEK TRIBUTARY 1
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS
SHEET 6 OF 9



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CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

WATER SURFACE PROFILES

CEDAR CREEK TRIBUTARY 1

SHEET 6 OF 9

WEST TRIBUTARY of SANDY CREEK

WATER SURFACE PROFILES

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

SHEET 7 OF 9

WATER SURFACE PROFILES

WEST TRIBUTARY of SANDY CREEK

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

SHEET 7 OF 9

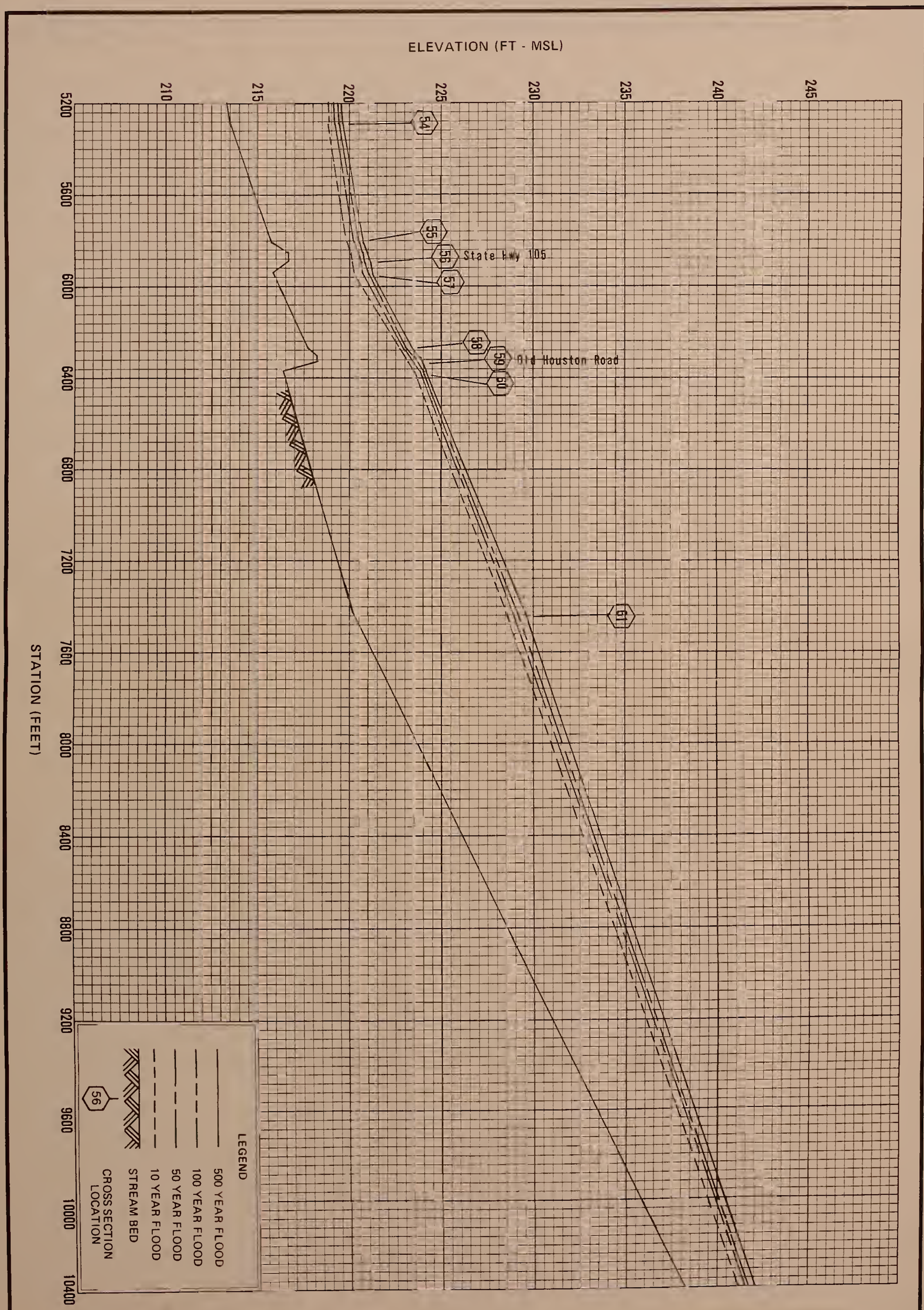
WEST TRIBUTARY of SANDY CREEK

WATER SURFACE PROFILES

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

SHEET 8 OF 9



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SOIL CONSERVATION SERVICE

CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

SHEET 8 OF 9

WATER SURFACE PROFILES

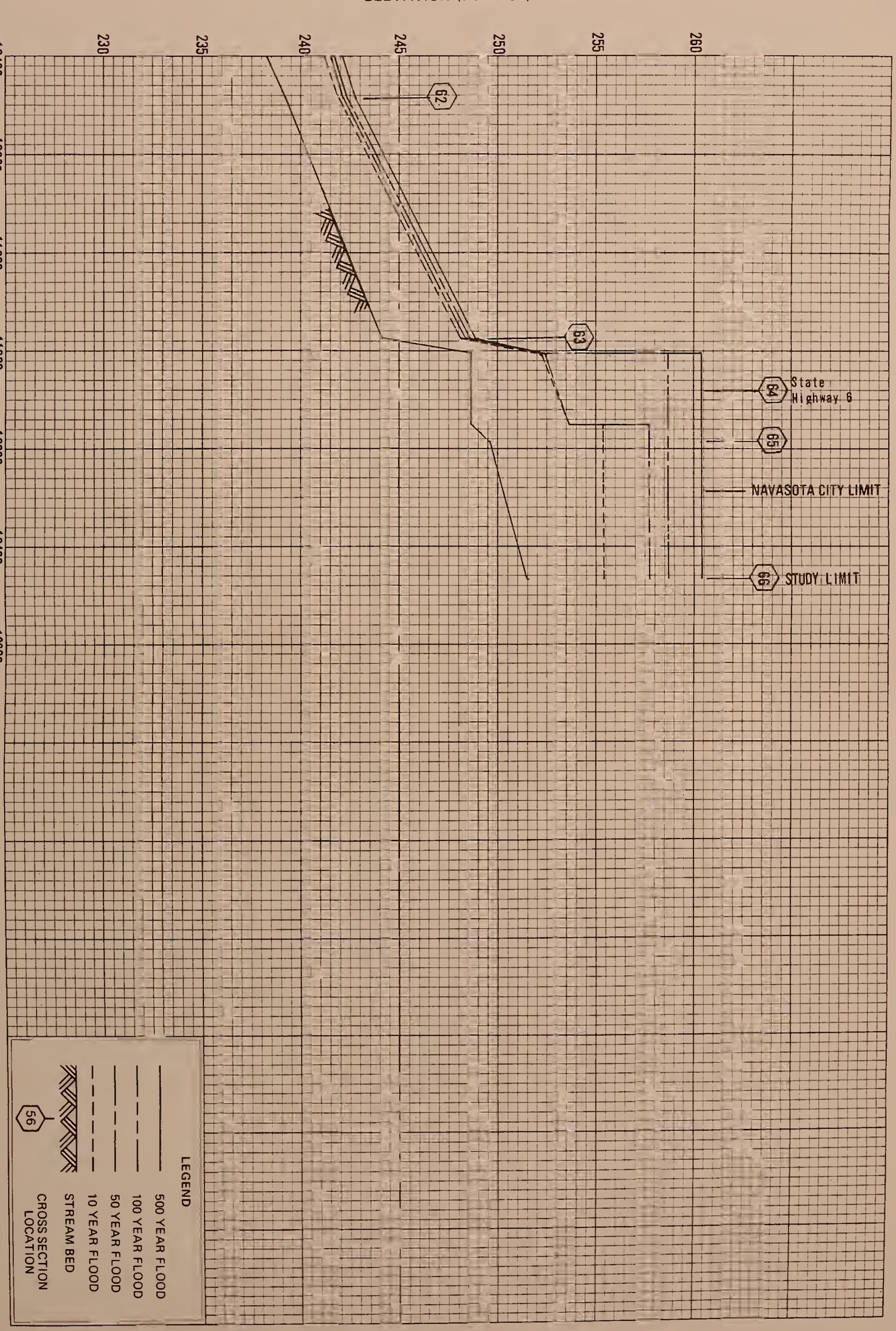
WEST TRIBUTARY of SANDY CREEK

WEST TRIBUTARY of SANDY CREEK

WATER SURFACE PROFILES

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

SHEET 9 OF 9



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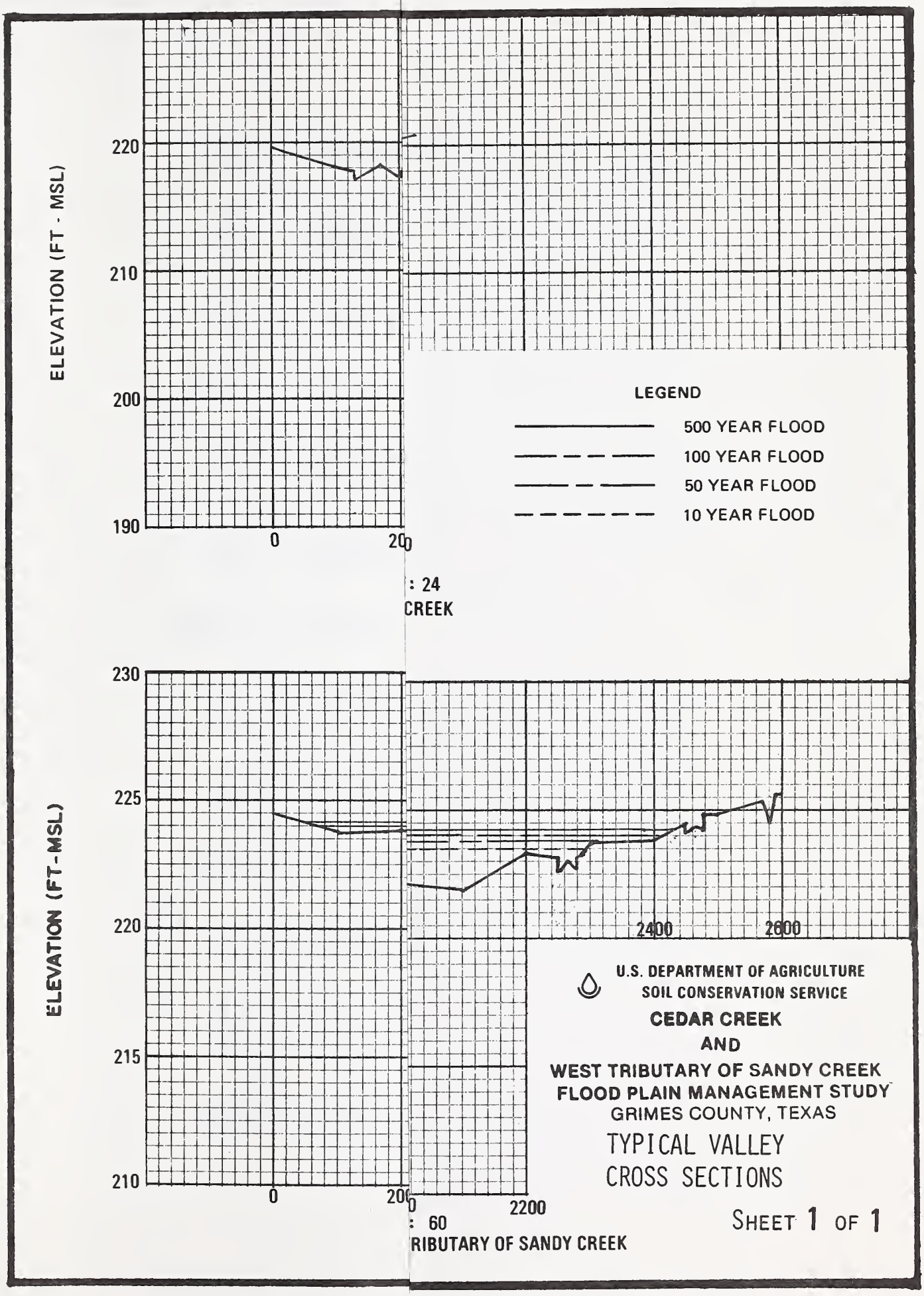
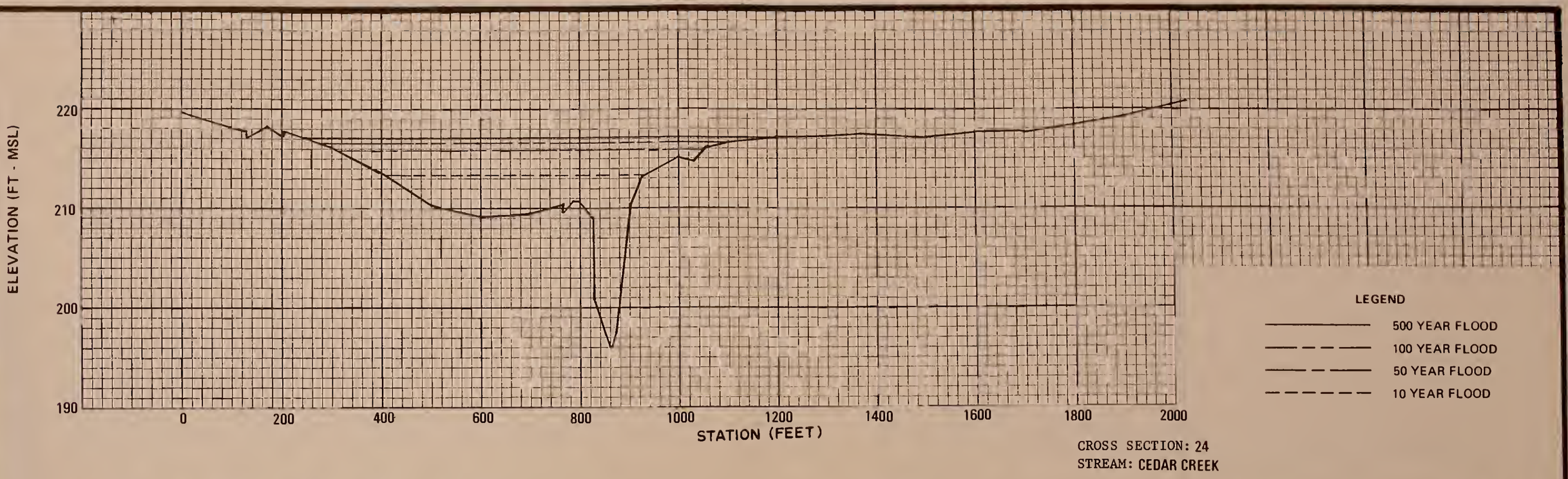
SOIL CONSERVATION SERVICE
CEDAR CREEK & WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

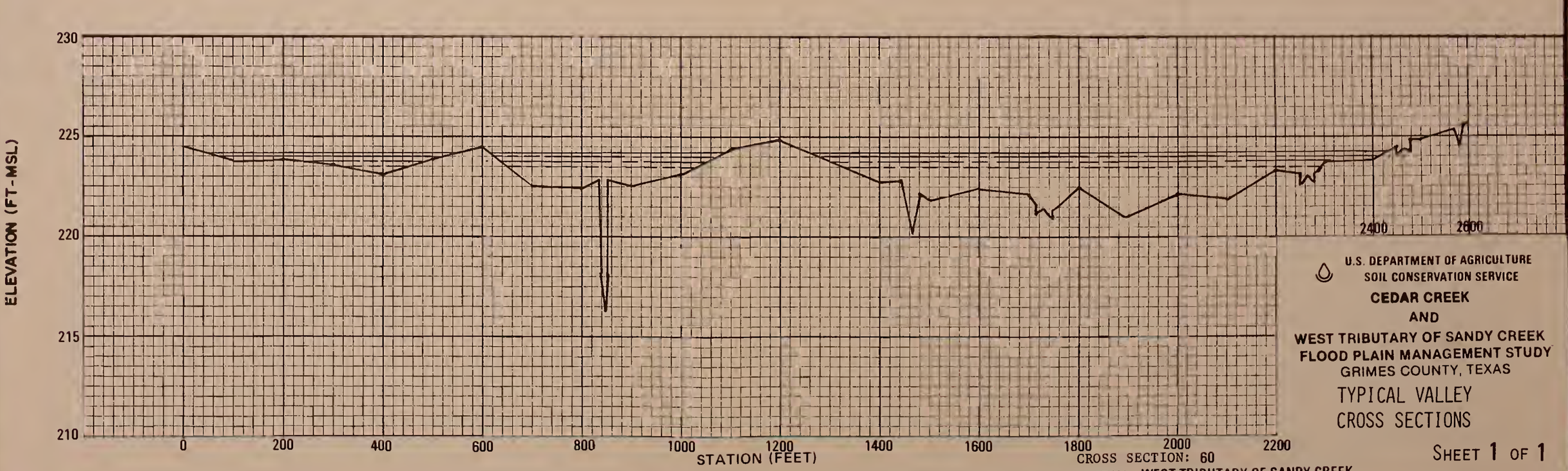
SHEET 9 OF 9

WATER SURFACE PROFILES

WEST TRIBUTARY of SANDY CREEK


ELEVATION (FT - MSL)
220
210
200
190
0
200
LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
: 24
CREEK
ELEVATION (FT-MSL)
230
225
220
215
210
0
200
2200
2400
2600
: 60
RIBUTARY OF SANDY CREEK
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
CEDAR CREEK
AND
WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS
TYPICAL VALLEY
CROSS SECTIONS
SHEET 1 OF 1





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SOIL CONSERVATION SERVICE

CEDAR CREEK
AND
WEST TRIBUTARY OF SANDY CREEK
FLOOD PLAIN MANAGEMENT STUDY
GRIMES COUNTY, TEXAS

TYPICAL VALLEY
CROSS SECTIONS

SHEET 1 OF 1

TABLE 2

CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK FLOOD PLAIN MANAGEMENT STUDY

ELEVATION AND DISCHARGE TABULATIONS

	PRESENT CONDITIONS											
	10-YEAR FREQUENCY			50-YEAR FREQUENCY			100-YEAR FREQUENCY			500-YEAR FREQUENCY		
CROSS SECTION NUMBER	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET
CEDAR CREEK												
1	5088	173.5	161	7444	176.6	203	9230	178.5	255	11988	180.9	373
2	5161	176.1	530	7561	178.8	597	9295	180.4	617	12104	182.7	1160 *
3	5290	183.1	654	7766	184.5	671	9408	185.4	681	12305	186.9	699
4	5298	190.4	530	7747	191.7	558	9497	192.5	577	12278	193.7	600
5	5304	192.5	428	7731	194.0	479	9570	194.9	508	12256	196.1	549
6	5304	193.8	119	7731	196.0	123	9570	197.5	123	12256	199.3	123
7	5304	193.9	506	7731	196.1	562	9570	197.6	609	12256	199.4	668 *
8	5306	194.8	325	7728	196.9	364	9585	198.4	408	12251	200.1	494
9	5306	194.8	110	7728	197.2	112	9585	199.8	410	12251	201.4	543
10	5306	195.0	173	7728	197.4	262	9585	199.9	514	12251	201.5	581
11	5207	198.4	581	7558	200.3	619	9451	202.0	654	12083	203.4	790 *
12	4668	203.7	366	6637	205.0	445	8710	206.3	508	11141	207.3	582 *
13	4668	205.0	359	6637	206.1	432	8710	207.2	507	11141	208.1	566
14	4668	205.0	396	6637	206.2	431	8710	207.2	484	11141	208.2	581
15	4707	206.3	63	6679	211.7	63	8703	214.8	810	11115	215.6	1413 *
16	4707	206.3	382	6679	211.7	643	8703	214.8	1445	11115	215.6	1485
17	4707	206.6	64	6679	214.4	1400	8703	215.5	1761	11115	216.0	1874
18	4746	207.0	142	6723	214.5	1837	8696	215.5	2023	11089	216.0	2242 *
19	4773	209.0	0	6752	214.8	1783	8691	215.8	1891	11071	216.4	2034 *

* Indicates island flow in the flood plain.

TABLE 2

CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK FLOOD PLAIN MANAGEMENT STUDY

ELEVATION AND DISCHARGE TABULATIONS

	PRESENT CONDITIONS											
	10-YEAR FREQUENCY			50-YEAR FREQUENCY			100-YEAR FREQUENCY			500-YEAR FREQUENCY		
CROSS SECTION NUMBER	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET
CEDAR CREEK (Cont'd)												
20	4773	209.1	58	6752	214.8	1555	8691	215.9	1979	11071	216.5	2152 *
21	4828	210.1	90	6812	215.1	1041	8681	216.1	2098	11035	216.8	2264 *
22	4828	211.4	424	6812	215.2	1564	8681	216.2	2159	11035	216.8	2300 *
23	4828	211.5	523	6812	215.2	1617	8681	216.2	2023	11035	216.8	2197 *
24	5165	213.3	515	7176	215.9	742	8625	216.6	815	10825	217.2	1167 *
25	5165	213.7	623	7176	216.1	838	8625	216.9	975	10825	217.5	1147
26	5165	213.7	576	7176	216.2	733	8625	216.9	783	10825	217.6	1417 *
27	5479	216.0	288	7512	217.7	449	8576	218.2	523	10645	218.9	583
28	4767	216.9	80	6593	218.9	348	7584	219.6	454	9486	220.5	578
29	4767	218.1	148	6593	220.4	558	7584	220.9	650	9486	221.5	763
30	4767	218.1	200	6593	220.4	473	7584	220.9	541	9486	221.5	620
31	3567	220.9	230	5025	222.9	303	5871	223.6	335	7462	224.6	420
32	3094	226.5	210	4398	227.9	317	5178	228.6	779	6633	229.6	904 *
33	3094	227.6	439	4398	228.8	673	5178	229.4	847	6633	230.4	1033
34	3094	227.6	339	4398	228.8	784	5178	229.4	841	6633	230.4	937 *
35	2931	235.3	915	4170	236.2	1224	4911	236.6	1278	6299	237.2	1353 *
36	1962	238.1	460	2805	238.7	510	3314	239.0	536	4294	239.5	578
37	1962	244.4	0	2805	247.6	0	3314	248.8	734	4294	249.1	1000
38	1962	244.6	922	2805	247.6	1178	3314	248.8	1239	4294	249.1	1255
39	1976	246.7	654	2813	248.7	944	3315	249.0	983	4283	249.5	1034

* Indicates island flow in the flood plain.

TABLE 2

CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK FLOOD PLAIN MANAGEMENT STUDY

ELEVATION AND DISCHARGE TABULATIONS

	PRESENT CONDITIONS											
	10-YEAR FREQUENCY			50-YEAR FREQUENCY			100-YEAR FREQUENCY			500-YEAR FREQUENCY		
CROSS SECTION NUMBER	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET
CEDAR CREEK TRIB. 1												
40	1217	239.8	206	1723	240.3	250	2024	240.6	274	2604	241.0	305
41	1217	243.9	0	1723	246.7	0	2024	247.7	0	2604	248.8	734
42	1217	244.7	494	1723	246.9	775	2024	247.7	844	2604	248.8	935
43	1232	251.3	462	1752	251.9	526	2063	252.1	547	2662	252.4	577
WEST TRIBUTARY OF SANDY CREEK												
44	1779	205.7	956	2784	206.3	977	3133	206.4	981	3823	206.7	991 *
45	1808	209.3	959	2788	209.9	981	3141	210.1	988	3806	210.3	995 *
46	2001	210.8	2259	3252	211.2	2260	3850	211.3	2261	4956	211.7	2540 *
47	2002	214.0	1925	3243	214.2	1975	3835	214.3	2000	4935	214.5	2033
48	2002	214.0	3180	3243	214.2	3200	3835	214.3	3215	4935	214.5	3240
49	2006	214.6	3056	3220	214.9	3060	3797	215.0	3062	4882	215.3	3067 *
50	2006	216.7	1464	3220	217.1	1900	3797	217.2	2033	4882	217.4	2611 *
51	2006	216.7	3023	3220	217.1	3029	3797	217.2	3030	4882	217.4	3033
52	2006	218.2	1640	3220	218.4	2994	3797	218.5	3029	4882	218.6	3063 *
53	2006	218.2	3122	3220	218.4	3142	3797	218.5	3156	4882	218.6	3171
54	2093	218.8	1827	3188	219.2	1938	3698	219.4	2010	4832	219.6	2038
55	2092	219.9	1730	3125	220.3	1795	3651	220.5	1829	4748	220.7	1862 *
56	2092	220.2	1170	3125	220.7	1431	3651	220.8	1483	4748	221.1	1656
57	2092	220.3	1782	3125	220.8	1822	3651	221.0	1838	4748	221.2	1854 *
58	2089	222.7	1503	2976	222.9	1550	3539	223.1	1623	4549	223.4	1891 *
59	2089	223.2	1567	2976	223.5	1752	3539	223.7	1977	4549	224.0	2196 *

* Indicates island flow in the flood plain.

TABLE 2

CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK FLOOD PLAIN MANAGEMENT STUDY

ELEVATION AND DISCHARGE TABULATIONS

	PRESENT CONDITIONS											
	10-YEAR FREQUENCY			50-YEAR FREQUENCY			100-YEAR FREQUENCY			500-YEAR FREQUENCY		
CROSS SECTION NUMBER	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET	DISCHARGE CFS	ELEVATION M.S.L. FEET	FLOOD PLAIN WIDTH FEET
WEST TRIBUTARY OF SANDY CREEK (Cont'd)												
60	2089	223.5	1970	2976	223.8	2233	3539	224.0	2339	4549	224.2	2394 *
61	2054	228.5	1140	2885	228.9	1260	3475	229.2	1309	4539	229.6	1365
62	1598	241.9	830	2235	242.2	866	2662	242.4	891	3449	242.8	940
63	991	248.2	553	1375	248.4	573	1603	248.6	594	2045	248.9	624
64	991	255.4	0	1375	257.7	0	1603	253.7	505	2045	260.4	1011
65	991	255.4	907	1375	257.7	1096	1603	258.7	1176	2045	260.4	1296
66	457	255.4	670	640	257.7	980	749	258.7	1073	959	260.4	1175

* Indicates island flow in the flood plain.

TABLE 3

BENCH MARK DESCRIPTIONS AND ELEVATIONS

FLOOD PLAIN MANAGEMENT STUDY

CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK

GRIMES COUNTY, TEXAS

Flood Hazard Area Sheet Number	RM Name	Elevation (Ft. MSL)	Description
1	N-16	242.76	Approximately 300' north of intersection of Stacey Street and west service road to Highway 6 (Loop), south end of west headwall of culvert under Highway 6 and on Cedar Creek, a chiseled "□".
2	N-14	233.73	In the southeast corner of the intersection of Victoria and Stacey Streets, on the west side of utility pole, railroad spike 0.6' above ground.
3	285	242.04	About 850' west of Highway 6 (Loop) along east-west fence line in base of 24" post oak tree, a bent 60d nail.
3	290	255.59	In southeast corner of Best Western Motel complex, on west side of west service road of Highway 6 (Loop), on east side of light pole with transformer, 0.6' above ground a 60d nail.
4	255	226.32	Approximately 0.6 mile east along FM 105 (Spur 515) from intersection of business Highway 6 to intersection of FM 105 and Courtney Road, in southeast part of intersection, on west end of south headwall of culvert draining into east borrow ditch of Courtney Road, a chiseled "□".

TABLE 3

BENCH MARK DESCRIPTIONS AND ELEVATIONS

FLOOD PLAIN MANAGEMENT STUDY

CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK

GRIMES COUNTY, TEXAS

Flood Hazard Area Sheet Number	RM Name	Elevation (Ft. MSL)	Description
4	280	230.10	About 600' northwest of old barns, in east base of 36" post oak tree, a 60d nail.
5	220	212.84	Approximately 1500' south along business Highway 6 from intersection of FM 105 (Spur 515) to culvert over West Trib of Sandy Creek, in center of west headwall of culvert, a chiseled "X".
5	235	218.43	Approximately 0.5 mile south along Courtney Road from intersection of FM 105 (Spur 515), about 100' north of Missouri-Pacific Railroad and about 30' west of centerline Courtney Road, in southernmost pole of "H" frame transmission line on southeast side of pole 0.8' above ground, a railroad spike.
7	N-11	230.90	In the northeast corner of the intersection of Washington and Borsig Streets, 2' west of fire plug, west anchor bolt of steel pole, top of bolt.
7	N-12	222.11	In the northeast corner of intersection of Borsig and Felder Streets, at curb joint, on top of curb, a chiseled "□".

TABLE 3

BENCH MARK DESCRIPTIONS AND ELEVATIONS

FLOOD PLAIN MANAGEMENT STUDY

CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK

GRIMES COUNTY, TEXAS

Flood Hazard Area Sheet Number	RM Name	Elevation (Ft. MSL)	Description
7	N-14	233.73	In the southeast corner of the intersection of Victoria and Stacey Streets, on the west side of utility pole, a railroad spike 0.6' above ground.
8	USC&GS S 206	213.822	At Navasota, Grimes County, on the old roadbed of the abandoned International Great Northern Railroad, 106 yards north of Texas and New Orleans Railroad milepost 71, at bridge No. 48.74, and in the top of the southwest corner of the bridge. A standard disk, stamped "S 206 1933".
8	N-1	212.27	In the northeast corner of intersection of Washington and 10th Streets, 1' west of fire plug, on top of curb, a chiseled "□".
8	N-3	205.17	On the west side of 5th Street, northeast corner of "RAILROAD CROSSING" sign's concrete base, a chiseled "□".
8	N-4	197.91	About 700' west of the 5th Street crossing along Santa Fe Railroad to bridge over Cedar Creek, in bridge abutment at southeast end of bridge, about 3.5' below track level, top of vertical bolt.

TABLE 3

BENCH MARK DESCRIPTIONS AND ELEVATIONS

FLOOD PLAIN MANAGEMENT STUDY

CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK

GRIMES COUNTY, TEXAS

Flood Hazard Area Sheet Number	RM Name	Elevation (Ft. MSL)	Description
8	N-7	215.51	In the northeast corner of the intersection of Washington and Duke Streets, 0.3' west of vertical railroad iron, top of curb, a chiseled "□".
8	N-8	216.03	In the northeast corner of the intersection of Washington and La Salle Streets 7" south of front line of business buildings, on the sidewalk, a chiseled "□".
8	270	241.13	In northwest corner of intersection of Anderson and Church Streets, 4' north of fire plug and on west side of Church Street, on south side of light pole with transformer, 0.5' above the ground, a 60d nail.
9	N-17	217.74	At northwest corner of intersection of business Highway 6 and FM 105 (Spur 515), about 40' east of southeast corner of light colored brick school building, directly under and in line with a three (3) arm transmission line on the north side and parallel with FM 105, on the west curb of business Highway 6, a chiseled "□".

TABLE 3

BENCH MARK DESCRIPTIONS AND ELEVATIONS

FLOOD PLAIN MANAGEMENT STUDY

CEDAR CREEK AND WEST TRIBUTARY OF SANDY CREEK

GRIMES COUNTY, TEXAS

Flood Hazard Area Sheet Number	RM Name	Elevation (Ft. MSL)	Description
10	203	209.14	Approximately 4000' south along Grimes County Road 419 from intersection of County Road 419 and FM 379 to a railroad siding track crossing County Road 419, about 100' west of Texas and New Orleans Railroad and approximately 1500' north of Sandy Creek, at center of intersection of county road and siding track, a railroad spike driven flush with asphalt road surface.
11	N-5	197.24	Approximately 400' south of the Navasota River, in a railroad sign post, a 60d nail.